SCIENCE

VOL. 77 | FRIDAY, JUNE 2, 1933 | No. 2005

SCIENCE: A Weekly Journal devoted to the Advancement of Science, edited by J. MCKEEN CATTELL and published every Friday by

THE SCIENCE PRESS

New York City: Grand Central Terminal

Lancaster, Pa. Garrison, N. Y.

Annual Subscription, $6.00 Single Copies, 15 Cts.

SCIENCE is the official organ of the American Association for the Advancement of Science. Information regarding membership in the Association may be secured from the office of the permanent secretary, in the Smithsonian Institution Building, Washington, D. C.

ACADEMIC AND INDUSTRIAL RESEARCH IN THE FIELD OF THERAPEUTICS[1]

By Sir HENRY H. DALE

DIRECTOR OF THE NATIONAL INSTITUTE FOR MEDICAL RESEARCH, LONDON, AND SECRETARY OF THE ROYAL SOCIETY OF LONDON

WE have to-day the privilege of assisting at the formal inauguration of these Research Laboratories, which the enterprise of a manufacturing house has brought into being. I know that I can speak for all those who are present, in saying to the directors whose enlightened policy has provided these laboratories, and to the distinguished investigators who will use them, that we wish them all the success which they desire and deserve. And in wishing them success, I have in mind not merely such as will directly increase the efficiency and extend the scope of the industrial enterprise with which these laboratories are associated, though that we may wish them without reserve; but we may also wish them a wider and more enduring success, in adding to the sum of life-saving knowledge, for the benefit of all mankind.

[1] An address delivered at the opening ceremony of the Research Laboratories of Merck and Company, Inc., Rahway, New Jersey, April 25.

The word "research" in relation to industry has been made to do duty over a wide range of meanings. You would probably find some manufacturers who apply the term to the mere experimental control of the details of an unprogressive technical routine, or of the quality of the materials used in it. At the other end of the scale, this great country, in particular, can show conspicuous examples of the far-seeing policy of great industrial enterprises, in providing opportunity for men of world-wide fame in science to follow freely the lead of their own original genius, without any immediate reference to the production of remunerative inventions. Results of the greatest theoretical importance to science have thus been obtained, which any university might be proud to claim as the product of its laboratories of pure research; but in some cases, at least, they have been obtained under conditions which only the technical resources of great industry could provide. I do not

think that we can have any doubt that, by such a policy, industry will not only render a proper service to the wider interests of the community from which it draws its support, but will also act in the essential interests of its own success and development. And it will do so, I think, not merely because some of the most important inventions, leading to really new lines of practical development, do in fact arise as incidental results of fundamental researches having no such practical aim, but also because the progress of such free scientific inquiry in any community creates the atmosphere of mental enterprise and the fount of ideas, which enable practical invention to thrive and to come to fruition.

There may be some who will see a danger here, fearing lest the opportunities offered by the research service of industry may come to make too large a draft upon the highest grade of scientific ability, so that the universities may be unable to make good their primary claim upon it, for the training and inspiration of the following generations. The danger is not one which could be treated lightly if there were any good reason to fear its development. For the scientific future of any country, in industry as well as in the academic sphere, must depend on the quality of the recruits which the universities can furnish; and that quality will be determined, not only by the effectiveness and the attractive influence of the formal teaching which they provide, but even more by the opportunity which they afford to their best students, of a living contact with the finest type of ability and achievement in research. If such a danger really existed, we could hardly put the responsibility for it only on industry. The great institutions, supported by private munificence or by public funds, and offering, to men selected for their achievement or promise as investigators, an opportunity to give the whole of their thoughts and energies to research, must share any responsibility of that kind. This country, through the unparalleled and enlightened generosity of its leaders of industry and finance, has led the world in this relatively new development of the endowment of research for its own sake. I myself have the honor now to be associated with an institute thus devoted entirely to medical research, with no formal academic contacts, supported from the public funds by the British Government. Earlier, after a relatively short academic experience, I had charge, for ten of my most active years as a scientific worker, of laboratories also concerned with various aspects of medical research—physiology, pharmacology, immunology, serology—and supported by the head of a great British pharmaceutical firm, Sir Henry Wellcome, who had migrated from your country to mine at an early stage of his career. I allow myself the apparent egotism of these personal details, only to make it clear that I have had the opportunity of viewing, from more than one angle, this problem of the relation between research in the universities, in endowed and public institutes and in laboratories supported by industry. And, so far as this experience has enabled me to form a judgment, I do not believe that there is any real or permanent danger of the universities losing, to whole-time research in endowed institutions or in laboratories associated with industry, the particular kind of scientific leadership and power of inspiration, which, in the interests of all kinds of scientific activity, it is essential that they should retain. So far as I can judge, I believe that, in general, this relatively new growth of whole-time research as a career is already effective, and is likely to become more so, in the reverse direction. In this, as in other spheres of human activity, supply must be largely determined by demand. The universities, in the nature of things, can offer only a limited number of major opportunities in science to their ablest and most enterprising students; and the more numerous the extra-academic opportunities for careers of distinction and of service to the community in research, the more readily will able men be willing to try their ability as investigators, before embarking on careers of professional practise or business; and the wider should be the field thus made available to the universities, in choosing the men they wish to retain and to promote. I do not think, then, that there is any real danger in that direction. Such difficulties as may arise, to hamper the development of the best and most helpful relationship between research in the universities and in the laboratories associated with industry, must come from causes of a different kind. In the field of medical science, which is that of my own direct experience, I am inclined to doubt whether the ideal relationship has yet been everywhere established, between research in the universities and the hospitals, on the one hand, and that associated with the pharmaceutical industry on the other. The finding and acceptance of a proper relationship, however, is vital to the progress of both alike, and to their union in an ordered advance, along the common front of medical science and its applications. It is a matter of special importance to an institution such as this, which starts to-day on its career, with the good wishes and the confident hope of us all. I hope, therefore, that I may be allowed to put briefly before you a few ideas as to the special kind of service which an organization such as this may render to medical science, and as to some of the difficulties which it may have to face.

Let us recognize, in the first place, that investigation in that group of sciences which contribute to medicine entails certain special obligations. The practitioners of medicine are bound, by a tradition of

long and honorable history, to place any new knowledge, gained in the practise of their art, freely at the disposal of their professional brethren, without any concealment or any attempt to restrict its use for private advantage. This tradition has no connection with any formal code of professional etiquette governing medical practise. Its basis, I think, is a recognition of an essential condition for the advance of medical science; and in recent years, as such advances have come in increasing measure from the research laboratories, the workers in these, whether medically qualified or not, have in general shown themselves eager to embrace this great medical tradition and to accept this freedom of the great medical brotherhood. Without committing ourselves too hastily in advance to the details of its application over the whole field of enterprise, I think we must accept this tradition as embodying a true ideal, and one which we can not afford to lose or to see obscured. For medical research differs from that in other fields in this respect, that its ultimate aim is the provision of knowledge which will find its application in the relief, the cure or the prevention of human sickness and suffering. Further, while all medical research, however remote from any immediate thought of such application, preserves this ultimate aim, no practical development of the results of medical research can be made, no therapeutic invention can be completed, without a full and frank cooperation with those engaged in clinical practise. Those who are engaged in the task, vitally important to the progress of medical science and practise, of translating the new knowledge of natural laws and principles into terms of practical therapeutics, as the workers in these laboratories will be, require the fullest confidence and cooperation of those, on the one hand, who are freely exploring new avenues of knowledge, without an immediately practical objective, and those, on the other hand, who are directly responsible for the care and the treatment of the sick. And in order that this frank and full cooperation and confidence may be established, between all those engaged in furthering medical discovery and its application at these different stages, they will need to convince one another that they are bound together in a common cause and by loyalty to a common tradition.

I think that we must frankly face the fact that those whose contribution to this common end is made by research in laboratories such as these may find a special difficulty in carrying that conviction. These laboratories have been founded by industry, and their maintenance and progressive opportunity of service to medical science will depend on the extent to which industry receives the proper reward of its enterprise. I have no fear that the directorate responsible for these laboratories will reckon that reward by any narrow calculation, based merely on returns from directly remunerative invention. But you men of science, who have accepted the opportunity which these laboratories offer, will probably find some among your academic or clinical colleagues who will be ready to assume that your researches, henceforward, will be directed merely to the promotion of some trade interest, to securing some advantage to the manufacturing house supporting you over its competitors and not to the advancement of the common cause of medical science. I say that you will probably find some ready to take this attitude, and to regard you as engaged in, at best, an inferior order of medical research; but it may be that I am wrong, and I hope that I am. I was speaking from the analogy, perhaps a misleading one, of my own experience in another country, and now nearly 30 years ago. I suspect, however, that human nature and academic traditions do not exhibit any fundamental differences over those parts of the world where our common language is spoken and that they do not change completely in the course of thirty years. If there is anything in my suspicion, it will be your task, as it was mine, to show these colleagues that they have been wrong in their assumptions; that work in these laboratories supported by industrial enterprise, though differing from theirs, perhaps, in the nature of its immediate objective, can be as genuinely inspired by the ideals of the advancement of medical science, and of service to suffering humanity; and that even in researches undertaken in the interests of some immediately practical development, the alert investigator, given such freedom as you will surely have here, will find the opportunity for making additions to the common fund of scientific knowledge, which may be as fundamentally important as those which come from the academic laboratories. They have had examples before them, indeed, for many years, from other laboratories established and maintained by great pharmaceutical houses in this country; and it must surely be generally recognized that some of the great advances in medical knowledge, which have in recent years come from American universities, have been made possible by the cooperation which only industrially supported research could give. But prejudice dies hard, especially when it has its roots in a tradition which we all acknowledge and respect; and I suspect that you who are to work here will find that there is, for yourselves and your colleagues in other similar institutions, something yet to be won, of the full confidence and cooperation which you need from the academic investigators and which they as certainly need from you. You will win it, when they see that your work differs from theirs, not so much in its quality or its ultimate aim as in the nature of

the incentive and in the kind of opportunity offered by the conditions under which it is done.

There is one matter, affecting the question of loyalty to a common medical tradition, which I must mention more explicitly, if only to free myself from the suspicion of shirking a difficulty. I refer to the question of patents for inventions having therapeutic value. I shall make no attempt to conceal my own wish that we could do without them. I am convinced that a general recognition of their use by research workers in the medical field would be unfavorable to open confidence and to the free interchange of experience and materials among such workers, including those whose part in a common investigation is concerned with the human patient. The whole basis of such cooperative work would be endangered by any suspicion that it was being used for the enrichment of some individual or institution, and not for the advancement of medical science for the common benefit.

That being said, I should make it clear that I am not among those who condemn the use of patents in medicine with a kind of dogmatic fervor and without reference to its object and its effect. The object of any patent law is to further the progress of science and its applications, by stimulating invention and by providing the conditions which will make its results available to all who need to use them. I believe that a general use of patents in all parts of the field of therapeutic research and by investigators in all kinds of institutions would definitely hinder, rather than promote, such progress. That belief, however, does not entitle me to suggest that the protection by patent of any kind of therapeutic invention, under any conditions and in any country, must of necessity have that detrimental effect. So far as I can judge the situation, the danger of it seems to me to be greatest in connection with discoveries relating to remedies of the biological type, for which the practical application is apt to present itself as a stage in the general advance of knowledge, to which many, in different institutions and countries, have made essential contributions. I believe that there is a definite danger here from the difficulty of distinguishing between scientific discovery and practical invention, and from the temptation to use the opportunity which a patent affords, not only to endow a particular institution in which a practical development happened to begin, but also to dictate to the whole world an orthodoxy in its application, and thereby to restrict the freedom of further advance. Frankly, I am inclined to regard the medical patent as a peculiarly dangerous weapon when it is wielded by the good intentions of the academic amateur.

On the other hand, I do not see the same danger in the use of patents for inventions related to really new substances of therapeutic value produced by chemical synthesis. I can not ignore the argument that an immediate and complete freedom to all the world for the manufacture and sale of such a substance might have the result of its not being produced at all, because nobody could justify the expenditure necessary to organize its efficient production and to make its value known to those who could use it. I think it could be urged that, under the conditions of modern pharmaceutical industry, in some countries, a patent for a definite invention of this kind may be used in accordance with the very purpose of medical tradition, to make the new knowledge available to all who need to use it. I think that it can also be urged that such a policy may enable an industry to support research leading to further and more important inventions. Without such incentive and guarantee it is hardly likely, I think, that the great pharmaceutical industry of Germany could have embarked on a policy which, after many years, has led to the production of substances representing the first clear advance in the treatment of malaria along new lines since the Jesuit Fathers brought cinchona bark from Peru in the seventeenth century; or that the pharmaceutical industry of this and other countries would have enriched the resources of medicine with all the new general and local anesthetics which now help to reduce the sum of human pain. If the industry of any country tells me that it can only promote research and apply its results, in this synthetic field of therapeutic invention, by the use of patents, I can not presume to contest the statement. But I am certain that patents in the medical field will do no service even to industry, unless they are so used that they serve also the great medical tradition, so that industry wins and retains the confidence of the academic laboratories and the clinics. No invention in the medical field can be completed or brought to use without the cooperation of the physician and his patients. I believe that such cooperation will be readily and properly given so long as it is clear that the aim of industrial research is the real increase of knowledge for the ultimate benefit of mankind and not the promotion of some narrow commercial aim.

The idea of cooperation involves some differentiation of function. It would not be in the general interest of science that the academic institutions and laboratories such as these should be following exactly similar lines of investigation, with the same kind of immediate objective. Broadly, we may distinguish their respective functions, I think, by saying that the primary task of those academic laboratories, which are concerned with the ultimate advancement of therapeutics, is the increase of our fundamental knowledge of the problems involved, without any immediate or insistent thought of its practical applica-

tion. The function of science in the universities seems to me to be well expressed in the old formula, which, since its foundation in the seventeenth century, has defined the purpose of the Royal Society of London —"the improvement of natural knowledge by means of experiment." That tradition has not needed any artificial importation into the universities of this country. One of the first and greatest of American citizens, Benjamin Franklin, was himself a distinguished fellow of the Royal Society. Your primary task in these laboratories, on the other hand, will be to find applications for the laws governing therapeutic action, as fundamental inquiry reveals them, and to translate them into the practical terms of remedies ready for the treatment of the sick.

Broadly, I think, this differentiation can be made, and I believe it to be important that it should be kept steadily in view. On the other hand, it is natural and proper that, from time to time, these functions should largely overlap. The academic investigator must certainly not be inhibited or called off from his quest, if its natural line of development should lead him to a discovery which is directly applicable to the prevention or treatment of disease. On the contrary, it is right that he should be the more encouraged to pursue his investigation, by the thought of its promise of immediate benefit to mankind. I suppose that we shall agree that the discovery, in the past century, which had the most revolutionary and transforming effect on medical science and practise was that of microorganisms as the cause of infective diseases; and its real starting point was the interest, awakened in the mind of a man of genius, Louis Pasteur, by the relation between the optical rotations of the different tartaric acids and the asymmetry of their crystals. He followed the clue through the differential fermentative action of moulds and of yeasts, to open a new world to investigation, in the bacterial origin of putrefaction and of many diseases. But, out of an unbounded admiration for that great man and for his wonderful gift to mankind, I am sometimes tempted to wonder whether that gift might not have been even greater, and in some of its phases more permanent, if the clamor for practical application had not led him, in later years, so far into the unfamiliar field of therapeutics, and away from his more fundamental inquiries. When Michael Faraday, patiently seeking the improvement of natural knowledge, with an inspired curiosity, discovered the phenomenon of electromagnetic induction, he probably had little thought that it would find any practical application; if he had had any prevision of the kind of civilization which, a hundred years later, would have arisen on his discovery, the thought would probably have appalled him. It will surely happen in the future, as in the past, that free and fundamental researches will often lead to the most important practical discoveries; and we need not grudge his good fortune to the academic investigator whose work has such a result. I do think, however, that there is a definite danger lest he should be diverted by it from his proper task of further free inquiry and should devote his interest to the practical development and application of a discovery already made, which, in many cases, he had better leave to others. The concentration of popular enthusiasm on discoveries which are immediately applicable in therapeutics is natural and intelligible. We need have no fear of its effect, provided that a proper balance of recognition is preserved within the universities themselves, between the achievement of a practical success and the fundamental advancement of knowledge. I have no right, and no desire, to criticize here a particular line of policy, which some of the universities of the North American continent have adopted in recent years, in order to secure to themselves funds for the endowment of further research, from the proceeds of practically useful medical discoveries which have come from their respective laboratories. It is for them to judge their needs and the proper way to meet them. I mention the matter, not from any desire to make or to imply a criticism of action already taken, but because of its direct bearing on a view which I desire to emphasize, namely, that the primary and special function of research in the universities is to build the main fabric of knowledge by free and untrammelled inquiry and to be concerned with the practical uses of it, only as these arise in the course of a natural development. I suggest that we should watch carefully the effect of any line of action which might lead the scientific departments of the universities to give encouragement and promotion to the practical inventor at the expense of withholding it from a potential Michael Faraday or Willard Gibbs. If that should happen, there would be a real danger of the university departments neglecting their own proper part in the cooperative scheme, and encroaching on that more proper to the laboratories supported by industry.

I have suggested, as the primary concern of the laboratories supported by industry, the development to a practical outcome of the fundamental discoveries which the academic and endowed institutions may be expected, in the main, to furnish. But just as the academic worker ought not to be restrained from following freely the line of his inquiry, because it happens to lead to a practical application, the investigator in an industrially supported laboratory ought to have a large freedom, to follow a clue to new knowledge of a fundamental kind, if it presents itself in the course of his practical investigations. Indeed, I think it is probably of great advantage to an

industrial laboratory that its staff should have always in hand a substantial body of investigation having no direct relation to any practical development. My own personal experience, if you will pardon a further reference to it, perhaps influences my views unduly. If the head of a great pharmaceutical house, who gave me my first real opportunity as an independent investigator, had been inclined to judge me by my output of therapeutic novelties directly remunerative to his firm, I think he must have concluded that I was a very unprofitable investment. If he did so, he never let me suspect it; on the contrary, I received a steady encouragement to follow, with my colleagues, the natural lead of the problems which our initially practical investigations had presented. And I believe that such a policy is undoubtedly the right one. If necessity is the mother of invention, the spirit of free investigation is most certainly its father. The men who work here will need it, to preserve their active interest in what is happening in the larger world of science, and to maintain their contacts with men of like interests in the academic world.

In a very large proportion of cases, when we come to look at the results, it will be difficult to say whether a particular discovery would come more appropriately from an academic or from an industrial laboratory. Permit me to illustrate the difficulty by an example which has some personal interest for me, as well as for these laboratories. Many years ago my friend, Dr. Reid Hunt, now professor in the Harvard Medical School, thought that he detected the presence, in an animal organ, of some unstable derivative of choline, of greater physiological activity than that substance. An examination of a series of artificial derivatives, with Dr. Taveau, led him to the discovery, in acetylcholine, of a substance having at least one thousand times the activity of the parent base. Some five years later, in the Wellcome Laboratories, I was still following up certain lines of inquiry on the pharmacology of ergot, which had been suggested to me as a subject when I entered that service. A remarkable type of activity showed itself in certain peculiar ergot extracts, and cooperative work with my colleague, Dr. Ewins, led to the isolation of the substance responsible for it, which proved to be acetylcholine. Acetylcholine thus passed from the class of synthetic curiosities into that of natural substances, and a fuller study of its action showed a remarkable relation between its effects on different organs and those produced by parasympathetic nerves. This work, in an industrially supported laboratory, had brought us no nearer to practical therapeutics than Professor Reid Hunt's original discovery had done; but it arose from a chance observation, for which only the industrial connection could have provided the opportunity and of which we were able to take advantage through our association with large-scale work. After another interval, created by the war, the next step was taken in an academic laboratory, when Professor Loewi, in Graz, showed that stimulation of the vagus nerve produces its effect on the frog's heart by releasing something remarkably similar to acetylcholine in its properties; but the quantities were far too small for direct identification. After another interval of years, now in an institute supported by the public funds, another chance observation enabled Dr. Dudley and myself actually to isolate acetylcholine from an animal organ, in quantity sufficient for complete identification. So that now we had evidence that this substance, the most powerful dilator of the arteries of which we have any knowledge, actually occurs as a natural constituent of the body, and almost certainly intervenes in the natural control of its functions. But still its instability, and the consequent evanescent nature of its action, while fitting it supremely for such a natural function, made it of very doubtful value for artificial application in therapeutics. And so the scene shifts again to the industrially supported laboratories, and the systematic search begins for allied esters of choline, with a similar but more persistent action. And already there is news of the discovery of several; of one from the laboratories of the ancestral house of Merck in Germany; of another, apparently of real therapeutic promise, from the research laboratories of this younger house of Merck, for the inauguration of which in their new form we have been invited here to-day. The pharmacological properties of this new substance, however, were first made clear by Simonart, working under academic conditions, in the laboratories of my friend, and for a time my close comrade in research, Professor A. N. Richards, of Philadelphia. I congratulate these laboratories on securing the cooperation and advice of Professor Richards in relation to their activities in fundamental research. The association, as you will see, has a double interest for me; but I take almost as much in tracing the successive stages of this investigation, from the academic to the industrial laboratories and back again, and in finding myself unable to suggest that the nature of the researches at any one stage was specially suited to an academic institution, and at another more appropriate to the function of an industrial laboratory.

I have spoken of the broad differentiation of aim and of function between academic and industrial research, and of the different types of ability and of temperament suited to each. There are men, indeed, of whom we could say with confidence that the associations of academic life are necessary for their happiness and their efficiency in research; and there are others of whom we could say with equal cer-

tainty that their best work would be done under such conditions as these laboratories provide. I believe, however, that the men so easily classified are relatively few, and that for a large majority the choice will be determined by the accident of opportunity, rather than by aptitude. For some of this majority, I suspect that the best conditions for the full development and maintenance of their powers of serving science might be provided by a successive or an alternating experience of the conditions of academic and of industrial research. The investigator who has been digging himself to a standstill in an academic groove, might find a new mobility in the less conventional surroundings of an industrial laboratory; while his colleague, whose inventive energies have grown stale from too long contact with a variety of practical problems, might find them refreshed and renewed by migrating for a period to the calmer atmosphere of fundamental research. I believe, then, that a freer interchange of suitable personnel, if it were possible, between the academic laboratories and those supported by industry, might have an invigorating influence on both; but I speak of ideals, without knowledge of practical possibilities. I am sure that even a short experience of the kind of opportunity that these laboratories will afford would make some of your academic colleagues envy the elasticity of organization, the adaptability of equipment and readiness of expansion to a large scale of working which the industrial association can give.

There are several advantages which you will have here over some institutions supported by memorial endowments. I am sure that this country must have had examples of a type of large-hearted testator or pious founder, familiar to us in England. He rightly believes that he can create the most worthy memorial to himself or to those dear to him by the endowment of medical research; but too often he wrongly believes that his generous impulse brings with it a scientific vision and a prophetic wisdom, entitling him to restrict, for all time, the application of his benefaction to research on some particular problem in medicine, which has enlisted his personal sympathies or stimulated his imagination. You who work here will be free to choose your problems, according to the needs of the time and the promise of advance offered by current progress in science; you will be able to give intensive cultivation to the fertile areas, to raise the crops which are likely to give good yield and put in the sickle where the harvest stands ripe for gathering. You will have the great advantage that your buildings can be designed and equipped, with the sole aim of making the most efficient provision for the work which you have in hand or in near prospect. You begin with an equipment perfect for your present needs, and will be able to expand it as your program and your staff expand. I can hardly resist a feeling of envy at the opportunity which Dr. Major, Dr. Molitor, Dr. Engels and their coworkers will have, to concentrate their thoughts on their researches, without distraction by duties of administration or teaching, in laboratories designed so admirably for the needs of research and so readily adaptable to changing requirements.

Whole-time research, however, whether in an endowed or an industrial laboratory, has its own special anxieties and psychological needs. Research workers in an institution such as this can only give of their best, if they can escape from any feeling of isolation from the general scientific community, and can feel an assurance that their work is making an essential contribution to the general advance of medical science and practise. They will need, and I am confident that they will have, all the encouragement and friendly cooperation which their scientific colleagues in the academic laboratories and the clinical centers can give them. We wish them all success, and we congratulate the president, Mr. Merck, and all who have been associated with him, on an enterprise which we now launch, with high hopes, on a career of service to science and to the industry which supports it.

OBITUARY

FRED E. BROOKS

FRED E. BROOKS, associate entomologist of the U. S. Bureau of Entomology and nationally known writer on nature subjects, died at French Creek, West Virginia, on March 9. He had been in ill health for several years and the immediate cause of his death was a heart attack. Mr. Brooks' first scientific work was done as associate entomologist of the West Virginia Experiment Station, where he did notable research work with insects affecting grapes. For some time he also worked with small mammals. In 1911 he became associated with the U. S. Bureau of Entomology, where his main work was with wood-boring insects, especially those working on apple. He also conducted research with codling moth, the grape curculio and several nut insects. Most of his research work is published in bulletins of the West Virginia Experiment Station and of the U. S. Department of Agriculture. In addition to entomology he was keenly interested in nature generally and published many papers covering his observations in journals such as *Nature, Country Life in America, The Rural New*

Yorker and many others. As an observer he was without a peer and it was in this way that he made his most notable scientific contributions.

C. R. CUTRIGHT

MEMORIALS

THE memory of John Kern Strecker, curator of the Baylor University Museum, was honored at Waco, Texas, on April 20, in a special service arranged by the Texas Academy of Science and participated in by the entire university. Eulogies were presented by H. B. Parks, of San Antonio, formerly state entomologist and secretary of the academy, and by Dr. Walter J. Williams, professor of mathematics, who was intimately associated with Mr. Strecker. The complete works of Mr. Strecker, assembled by the academy and bound in leather, were presented to the Baylor University Library. Included were ninety-three contributions on mollusks, reptiles, birds and mammals. About twenty papers were incomplete at the time of his death. These will be brought to completion by Dr. Williams and published as soon as possible. Mr. Strecker's death occurred at Waco on January 9.

A JAMES WATT MEMORIAL INSTITUTE was declared open at Birmingham, England, on May 15, by Mr. Alan Chorlton, M.P., president of the Institution of Mechanical Engineers. The premises are a wing of the recently erected York House and include a lecture hall, a library and a committee room. When in 1919 Birmingham celebrated the centenary of James Watt a fund was raised which, after paying the commemoration expenses and the cost of a memorial volume, enabled the trustees to set aside £5,000 for a research scholarship in mechanical engineering in Birmingham University. A sum of £6,000 remained. Sir Gilbert Barling, chairman of the trustees, explained that originally it was hoped to endow a chair of mechanical engineering at the university, which would have required £20,000. Eventually they visualized the erection of a fine building as a memorial home for the various engineering societies in Birmingham. Unfortunately the amount subscribed was very much less than was contemplated. Hence the position had to be reconsidered. Their £6,000 had now grown to £10,000, and as at least £40,000 was needed to erect an appropriate building the trustees decided to proceed in a small way with a view to future development. As a home for engineering societies the purpose of the institute would be educational and scientific. To run it in a fruitful manner they needed about £800 a year, and they were already assured of nearly £700.

Nature reports that shortly after the death of Professor John Henry Poynting in 1914 a fund was subscribed by his friends with the object of providing a memorial to him. Part of the money thus raised was used for the publication by the Cambridge University Press of a volume of his "Collected Scientific Papers," of which a copy was presented to every university in the British Empire and to representative universities in foreign countries. Another part of the fund was used for the purchase of a portrait to be presented to the University of Birmingham and hung in the great hall of the university. The remainder, which was invested, together with the accrued interest, has been offered to, and accepted by, the council of the university, for the foundation of a Poynting lecture, to be delivered at intervals of not more than two years by physicists of outstanding distinction.

RECENT DEATHS

DR. WILLIAM T. COUNCILMAN, Shattuck professor of pathology at the Harvard Medical School until his retirement with the title of professor emeritus in 1922, died on May 27, in his seventy-ninth year.

DR. JOHN CHALMERS DA COSTA, for more than forty years connected with the Jefferson Medical College, Philadelphia, filling the Samuel D. Gross chair of surgery since 1900, died on May 16, at the age of seventy years.

Nature reports the death of John Mackereth, a deputy conservator in the Indian Forest Service, on May 5, aged thirty-four years, and of J. T. J. Morrison, emeritus professor of forensic medicine and toxicology in the University of Birmingham, on May 10, aged seventy-six years.

THE recent death of Dr. Halfdan Bryn, Trondheim, is announced at the age of sixty-nine years. A correspondent writes: "With him Norway has lost its greatest anthropologist. Bryn was for some years president of the Norwegian Medical Association and was a member of the Consultative Eugenics Commission of Norway."

SCIENTIFIC EVENTS

THE SCIENTIFIC SITUATION IN GERMANY

A WIRELESS to *The New York Times* from Berlin reports that the Kaiser Wilhelm Society for the Advancement of the Sciences, the foremost scientific organization in Germany, which conducts thirty-two research institutes, held its twenty-second annual meeting here on May 23. It was presided over by Professor Max Planck, who said that nowadays no

one in Germany could be permitted to stand aside, "rifle at rest." He declared that there was only one watchword—"the consolidation of all available forces for the reconstruction of the fatherland." He read the following message sent by the society to Chancellor Hitler: "The Kaiser Wilhelm Society for the Advancement of the Sciences begs leave to tender reverential greetings to the chancellor and its solemn pledge that German science is also ready to cooperate joyously in the reconstruction of the new national state."

Dr. Wilhelm Frick, Minister of the Interior, told the scientists what the state expected from them if it was to look after them. "It is the nature of scientific thought and research so to engross man as to expose him to the danger not only of becoming severed from the greater whole but actually losing his sense of duty—forgetting that he must serve the community," he declared. "With all respect for the freedom of science, let us postulate that service to science must be service to the nation and that scientific achievements are worthless when they can not be utilized for the culture of the people."

No more scientists of Jewish extraction have been eliminated from the Kaiser Wilhelm Society's institutes, and among the elective members of its governing board three persons of the Jewish faith were reelected.

The investiture of Professor Ernst Krieck with the rectorship of the University of Frankfurt, which was renamed Goethe University last year, took place on May 23. The new rector said that in recent years the universities had lost a central idea, had become sidetracked and "never could have struggled from their paralysis but for the folk renascence. The chief characteristic of this rebirth is the replacement of the humanistic ideal by the national and political. Nowadays the task of the universities is not to cultivate objective science but soldierlike, militant science, and their foremost task is to form the will and character of their students."

A correspondent writes from Holland: "The declaration against Einstein, published by the Prussian Academy of Sciences, was not decided upon at a session of the academy. Tactical motives may have caused the subsequent recognition of the declaration by the academy. The first declaration was signed by the presiding secretary, Heymann, alone. He is, along with the orientalist, Lüders, permanent secretary of the Philosophical-Historical Division. The second declaration was signed by Heymann and Von Ficker. Von Ficker is one of the permanent secretaries of the Mathematical-Physical Division. The other permanent secretary is Max Planck, who was in southern Italy at the time of the declarations."

IN HONOR OF THE LATE STEPHEN TYNG MATHER

A MONUMENT, erected in honor of Stephen Tyng Mather, first director of the National Park Service, was unveiled by Mrs. Franklin D. Roosevelt, on May 27, at Bear Mountain, New York, at dedication ceremonies on the occasion of the meeting of the National Conference on State Parks, which was held from May 23 to 26. Mr. Mather's widow, a resident of Darien, Connecticut, and his daughter, Mrs. Edward McPherson, of Ithaca, were present at the ceremonies.

Mrs. Roosevelt, before drawing aside the red, white and blue curtain which veiled the plaque, remarked briefly that it was "a joy to have Mr. Mather's work recognized and commemorated." The plaque is a bronze tablet set in the face of a mammoth boulder. Designed by Bryant Baker, it bears Mr. Mather's profile against a background suggestion of mountains and trees, with the dates of his life span, July 4, 1867, to January 22, 1930. Its inscription reads: "He laid the foundation of the National Park Service, defining and establishing the policies under which its areas shall be developed and conserved unimpaired for future generations. There will never come an end to the good that he has done."

The Secretary of the Interior Harold L. Ickes, who flew from Washington for the dedication, said that Mr. Mather's record of achievement was

as far flung and enduring as the great national parks whose true mission in our national life he first conceived and expressed.

Stephen Mather was a fortunate dreamer of dreams who had the rare chance to follow his dreams and to make them come true. Before he came into our national park system, a park was just a park, an interesting or beautiful expanse of woods and lakes and mountains, without intimate connection with the lives of the people. He conceived the theory that our parks should be made the means of preserving the health and maintaining the morale of the American people.

To do what he did it was necessary not only that he love the mountains and forests and all the beautiful handiwork of nature, it was equally necessary that he should truly love just people. And it is hard to say whether he loved nature more than people or people more than nature. It is probably well within the truth to say that he loved both of them equally and that when he had them in conjunction he loved them both supremely.

It is keeping well within the bounds of truth to say that our great system of national parks and state parks providing, as they do, a means of out-door recreation unequaled in the history of the world, is largely due to the love of humanity and of nature that burned deep within the soul of Stephen T. Mather. He knew all the national parks intimately. He knew every employee in the service. They loved him and knew him as their friend and their affection and loyalty he returned in full measure. To the

extent that so many thousands of acres could feel the personal touch of any man, every section of every national park felt the personal touch of this great conservationist and lover of humanity. And they responded generously to that touch.

FIELD CONFERENCE OF THE NEW YORK STATE GEOLOGICAL ASSOCIATION

THE New York State Geological Association convened for the ninth annual field conference on May 12, at Newburgh, New York. In the morning thrust contacts of the Precambrian crystallines of the Highlands on the Paleozoic sediments were examined at Snake Hill, near Newburgh, and at Cornwall-on-Hudson, and the Precambrian intrusives were studied at the east end of Bear Mountain Bridge. After stopping for lunch at Mohansic Country Club, the cars were driven along the parkways to northern Manhattan and The Bronx, New York City; exposures of the Fordham gneiss, Inwood marble and Manhattan schist were visited. In the evening, a dinner was held at Columbia University in conjunction with the Geology Journal Club.

On Saturday, May 13, the first stop was at the diabase with included olivine zone along the state road above Edgewater, New Jersey. After crossing the Palisades, the remainder of the morning was spent in the Belmont-Gurnee quarry at Granton, where a contact of Newark sediments and intrusive basalt is well exposed; many specimens of the branchiopod *Estheria ovata* Lea and of ganoid fishes were obtained. After lunch in Jersey City, the party visited the exposures of the Staten Island serpentine and the moraines on Staten Island, New York.

About eighty members, many of them undergraduates in the universities and colleges in the state, attended the excursion. Professor R. J. Colony, of Columbia University, was president.

G. MARSHALL KAY,
Secretary

GROUP CONFERENCES AT THE COLD SPRING HARBOR BIOLOGICAL LABORATORY

AS a part of its policy of fostering a closer relationship between biology and the basic sciences, the Biological Laboratory at Cold Spring Harbor is inaugurating a plan, according to which it invites each year a group of mathematicians, physicists, chemists and biologists, actively interested in some one phase of quantitative biology, to carry on their work, and to engage in a group conference at the laboratory during the summer. The aim is that every important aspect of a given subject should be adequately represented from the physical and chemical, as well as from the biological, point of view.

"The Potential Difference at Interfaces and its Bearing upon Biological Phenomena" is the subject this year, and the following men will be in residence:

- Harold Abramson, biochemistry, College of Physicians and Surgeons, Columbia University.
- David R. Briggs, chemistry, The Otho S. A. Sprague Memorial Institute, University of Chicago.
- Barnett Cohen, physiological chemistry, the Johns Hopkins School of Medicine.
- Kenneth S. Cole, physiology, College of Physicians and Surgeons, Columbia University.
- Stuart Mudd, bacteriology, the School of Medicine, University of Pennsylvania.
- Hans Müller, physics, Massachusetts Institute of Technology.
- Eric Ponder, biology, Washington Square College, New York University.

In conjunction with this meeting, a series of lectures and symposia will be given by members of the group in residence and by other invited speakers. The latter include:

- Robert Chambers, biology, Washington Square College, New York University.
- Hugo Fricke, biophysics, the Biological Laboratory.
- Herbert S. Gasser, physiology, Cornell University Medical College.
- Duncan A. MacInnes, physical chemistry, Rockefeller Institute for Medical Research.
- L. Michaelis, physical chemistry, Rockefeller Institute for Medical Research.
- W. J. V. Osterhout, botany, Rockefeller Institute for Medical Research.
- Donald D. Van Slyke, chemistry, Rockefeller Institute for Medical Research.

The symposia will take place on each Wednesday in July, and on Monday, July 24, and Friday, July 28, beginning at 10 A. M., and continuing, with ample time for discussion, throughout the day. Individual lectures will be given on other days, according to a schedule which may be obtained from the laboratory.

PROFESSOR HARRISON AS CROONIAN LECTURER

DR. ROSS G. HARRISON, Sterling professor of biology at Yale University, has been invited by the Royal Society to give the Croonian Lecture in London, and will speak on a lectureship which began with Alexander Stuart in 1738, the roster of which includes the distinguished anatomists and physiologists of Great Britain during two centuries, with very few from other countries. A correspondent writes:

Professor Harrison, who last year received the honorary degree of doctor of science from Trinity College, University of Dublin, in recognition of the fact that "in his own science he is one of the most famous discoverers and teachers of the New World," was the first to show that

it is possible to remove groups of individual cells from the living body, and grow them in the body juices in such a way that their behavior can be watched under the microscope. This growing of groups of living cells is known as "tissue culture," and has constituted a great step forward in the study of living cells and consequently in the investigation of diseases. He has employed this method to trace the development of embryonic cells into differentiated cells, and his transplantations of pieces taken from an embryo into another place, or even into a different embryo, have elucidated much that was previously obscure.

Managing editor of the *Journal of Experimental Zoology* since its foundation in 1904, Dr. Harrison was the first to observe directly the outgrowth of the nerve fiber, showing that it is a mode of protoplasmic movement. His links with zoologists in this and other countries are many. He is a member of the National Academy of Sciences and the American Philosophical Society, a fellow of the American Academy of Arts and Sciences, and has been honored by scientific societies of Germany, France, Italy, Norway and Austria.

Professor Harrison's most intimate connections, however, are through the students trained in the Osborn Zoological Laboratories at Yale. During his directorship a total of 58 Ph.D. degrees have been conferred upon students from the department of zoology, of whom some forty are now professors in twenty-five institutions. In addition, post-doctoral research students come each year to Yale University to study his technique. In recent years they have included investigators from China, Russia, Belgium, France, Germany, etc.

The lectureship to which Professor Harrison has been invited was founded by William Croone, a successful practising physician and lecturer to the Company of Surgeons in London, who contributed information far in advance of his time on muscular physiology and the embryology of the chick. He was one of the founders of the Royal Society and in the remarkable group of its early members, which included Sir Isaac Newton, Sir Christopher Wren, Halley, the astronomer, and the two great diarists, Evelyn and Samuel Pepys, his contributions to the discussion of the society are noted in the records.

SCIENTIFIC NOTES AND NEWS

The University of Wisconsin will confer, at the annual commencement exercises on June 19, the doctorate of laws on Dr. Arnold Sommerfeld, professor of mathematics at the University of Munich, and the doctorate of science on Dr. James Aston, professor of mining and metallurgical engineering at the Carnegie Institute of Technology, Pittsburgh.

The degree of Sc.D., *honoris causa,* will be conferred by the University of Cambridge on the Marchese G. Marconi and on Sir Frederick Gowland Hopkins, Sir William Dunn professor of biochemistry.

The University of Liverpool has conferred the degree of doctor of science on Dr. Geoffrey Ingram Taylor, Yarrow research professor of the Royal Society.

For the development and promotion of agricultural exploration and the introduction of new and valuable plants into the United States, the committee on the Marcellus Hartley Fund of the National Academy of Sciences has awarded its Public Welfare Medal to Dr. David Fairchild, of the Division of Foreign Plant Introduction, Bureau of Plant Industry of the U. S. Department of Agriculture. The medal is given for "eminence in the application of science to the public welfare."

For chemical research work of high significance as pure science and of equally high value in its practical application, two research workers, Dr. F. B. La Forge and Dr. H. L. J. Haller, of the U. S. Department of Agriculture, have been awarded the Hillebrand Prize of the Chemical Society of Washington, for the determination of the chemical structure of rotenone, a new substance used in insect poisons.

Dr. David Eugene Smith, professor emeritus of mathematics at Teachers College, Columbia University, has been decorated by Persia for his study of the mathematical works and philosophy of Omar Khayyam.

Dr. E. D. Merrill, director of the New York Botanical Garden, was elected a foreign member of the Linnean Society of London at the meeting on May 11.

Dr. C. Tate Regan, director of the British Museum (Natural History), has been elected a foreign member of the Royal Danish Academy.

A wireless dispatch to *The New York Times* states that Professor Albert Einstein, who has received a professorship in the Collège de France, has been proposed for membership in the French Academy of Sciences. After favorable discussion, the proposal was postponed for inquiry as to whether Professor Einstein's election was possible under the academy's rules, which state that before a foreigner can be named as an associate member he must first have served as a corresponding member.

At a special dinner on May 5 at which the faculty of Harvard University and the governing boards of the university and of the Peter Bent Brigham Hos-

pital were present, a portrait of Dr. Harvey Cushing, who recently retired from the Moseley professorship of surgery at the university and as surgeon-in-chief of the hospital, was presented to the hospital, and a portrait of Dr. Henry A. Christian, Hersey professor of the theory and practise of physic and physician-in-chief to the hospital and from 1908 to 1912 dean of the medical school, was presented to the university.

INFORMAL exercises were held on May 21 in the Chemistry Library at the University of Illinois in connection with the presentation of portraits of three of its distinguished chemists, Professor A. W. Palmer, Professor S. W. Parr and Professor W. A. Noyes, by the Association of Illinois Chemists to the University of Illinois. Professor Palmer was head of the department of chemistry from 1894 to 1904, Professor Parr was professor of applied chemistry from 1890 to 1926, and Professor Noyes was head of the department from 1907 to 1926. Dr. Norman W. Krase, who had charge of the arrangements for the painting of the portraits, presided. Professor Roger Adams, head of the department of chemistry, after speaking briefly of the history of the department and of the accomplishments of Professors Palmer, Parr and Noyes, presented the portraits to the university. President Harry Woodburn Chase accepted the portraits. Professor W. A. Noyes related some of the facts connected with the development of the chemistry department with which he has been so long associated.

PROFESSOR CHARLES F. SCOTT, for twenty-two years chairman of the department of electrical engineering at Yale University, will retire from active teaching in June. His colleagues held a reception on May 19 in his honor, when Professor Russell H. Chittenden, formerly director of the Sheffield Scientific School, presented a collection of letters of congratulation and appreciation.

DR. H. A. BUEHLER was the guest of honor at a testimonial dinner at Rolla, Missouri, on May 10, in celebration of his twenty-fifth anniversary as state geologist of Missouri. He was appointed to this position in May, 1908, and has served continuously since that time. Dr. Buehler's distinguished services to the state and particularly his participation in the development of the mineral industry of Missouri were reviewed by a number of speakers.

DR. FELIX D'HERELLE has resigned from the professorship of bacteriology which he has held at Yale University since 1927. While in residence Dr. d'Herelle confined himself largely to the study of bacteriophagy as a laboratory phenomenon, since suitable clinical material was lacking. It is the hope of elaborating his work in the clinical field, possibly at the new institute for infectious diseases at Tiflis, Russia, which now takes him abroad.

DR. LOREN ROSCOE CHANDLER, of the department of surgery at the Stanford Medical School, has been appointed dean to fill the vacancy caused by the recent death of Dr. Henry G. Mehrtens.

PROMOTIONS at Yale University include Dr. Harry Martin Zimmerman to a professorship of pathology and Dr. Dirk Brouwer to an assistant professorship of astronomy.

THE Senate of Queen's University, Belfast, has appointed Mr. P. T. Crymble to the chair of surgery in succession to Professor Andrew Fullerton.

Nature states that Dr. M. Dixon has been appointed to the university lectureship in biochemistry, established in connection with the scheme for the employment of the Rockefeller benefaction to the University of Cambridge, and Dr. E. G. Holmes has been appointed to the university lectureship vacated by Dr. Dixon.

DR. FRITZ KNOLL, of Prague, has been appointed professor of botany at the University of Vienna.

THE following new full-time appointments have been announced in the School of Medicine, George Washington University: Edward Bright Vedder, professor of experimental medicine and executive officer, department of pathology and experimental medicine; Dr. William Henry Waller, instructor in anatomy; Dr. Jesse Harmon, instructor in biochemistry; Dr. Hubert Scott Loring, instructor in biochemistry; Dr. James Leslie Snyder, instructor in pathology, and Dr. John Ralston Pate, teaching fellow in anatomy.

DR. JAMES ANGUS DOULL, head of the department of public health and hygiene of the School of Medicine of Western Reserve University, Cleveland, sailed from Vancouver on May 25, to spend the summer establishing experimental work for the Leonard Wood Memorial Foundation for the Eradication of Leprosy in the Philippine Islands. Dr. Doull will work at Culion and Cebu, where the foundation has leper colonies.

DR. E. D. MERRILL, director of the New York Botanical Garden, will attend the fifth Pacific Science Congress, Victoria and Vancouver, B. C., as an official representative of the U. S. Government, the National Academy of Sciences, the American Philosophical Society and the New York Botanical Garden.

PROFESSOR ARTHUR H. COMPTON gave a public lecture at the University of Iowa on May 12 on "Cosmic Rays on Six Continents." He also gave two technical lectures on May 12 and 13 on "Some Recent Experiments with Cosmic Rays."

DR. OSCAR RIDDLE, of the department of genetics of the Carnegie Institution, on April 28 addressed the Brown University Chapter of Sigma Xi on "Sex and Reproduction," and the Biology Seminar on "Hormones of the Anterior Pituitary."

DR. CHARLES R. STOCKARD, professor of anatomy, Cornell University, gave a lecture at the hospital of Duke University on the "Peculiar Form and Type in Man and Animals" on April 8; on May 3 Dr. Otto H. F. Vollbeahr lectured on old and rare books, and on May 15 Dr. Arthur Steindler, professor of orthopedics in the State University of Iowa, gave a clinic on "The Low Back."

DR. ROBERT P. FISCHELIS, secretary and chief chemist of the Board of Pharmacy of the State of New Jersey, will deliver the commencement address to the graduating class of the Connecticut College of Pharmacy at New Haven, on the evening of June 5. His subject will be "Pharmacy's Contribution to Public Health Service."

THE Bakerian lecture of the Royal Society was delivered on May 25 by Dr. J. Chadwick, who took as his subject "The Neutron."

THE Geological Society of Chicago held its last spring meeting on May 18. The speakers were Dr. Theo. A. Link, Imperial Oil Company, and Professor C. A. Heiland, Colorado School of Mines, whose subjects, respectively, were the exhibits of petroleum geology and of geophysical methods at the Century of Progress Exposition at Chicago.

THE annual initiation dinner and meeting of the New York University Chapter of the Society of the Sigma Xi was held on May 19 at the University Faculty Club. Mr. Barnum Brown, curator of fossil reptiles at the American Museum of Natural History, addressed the society on "Dinosaurs of North America, Particularly Those of the Cretaceous Period." At this meeting twenty-three new members were inducted. Officers were elected for the next academic year as follows: *President,* Professor R. R. Renshaw; *Vice-president,* Professor Charles W. Lytle; *Secretary-Treasurer,* Professor Harry G. Lindwall.

THE luncheon given by Section C and the Chicago Chemists Club at the time of the meeting of the American Association for the Advancement of Science will be at 12:30 on Tuesday, not Thursday as stated in the preliminary announcement.

A SYMPOSIUM on "Nationalism" will be held by Section L of the American Association for the Advancement of Science in the auditorium of the Chicago Historical Society at Chicago on Monday, June 26, at 8:00 P. M. This has been organized by means of assistance generously provided by Dr. Duren J. H. Ward and the Far Reaching Foundation of Denver, Colorado. The presiding officer will be Professor James A. James, of Northwestern University, and the speakers and their subjects will be: Professor Bernadotte E. Schmitt, University of Chicago, "Nationalism in European History Since the Times of Napoleon"; Dr. Charles A. Beard, president of the American Historical Association, "Nationalism in American History"; Dr. Albrecht Mendelssohn Bartholdy, director of the Institute of Foreign Affairs, Hamburg, "Imperialism, Nationalism and International Peace." The discussion will be led by Professors Bernard Faÿ, of the Collège de France, and Charles E. Merriam, of the University of Chicago.

A ONE-DAY conference on problems relating to death from asphyxiation was held at the New York Academy of Medicine on May 24, under the auspices of the Society for the Prevention of Asphyxial Death. Dr. Paluel J. Flagg, president of the society, was chairman of the conference. Dr. Linsly R. Williams, director of the Academy of Medicine, delivered an address of welcome. The speakers included Health Commissioner Shirley W. Wynne, Dr. Harrison P. Martland, medical examiner for Essex County, New Jersey; Albert W. Whitney, associate general manager of the National Bureau of Casualty and Surety Underwriters; Dr. Daniel J. Donovan, chief surgeon of the New York City Police Department, and Dr. Yandell Henderson, professor of applied physiology of the Yale University Medical School.

THE annual excursion of the Physiographers and Geographers Club of New York City took place on May 20 as a bus trip for the purpose of studying the Triassic Basin of New Jersey, under the guidance of Dr. Bertram T. Butler, of the College of the City of New York. All the rock formations of the Triassic were studied in various quarries, the intrusive Palisade and Sourland Mt. ridges were visited as well as the surface lava flows forming the Watchung ridges. The large river systems, including the Delaware, were surveyed. Several volcanic centers, as Cushetunk Mt. and Bellvale, were included. Professor J. E. Woodman, of New York University, is president of the club; the secretary is Dr. Anna Welnitz. An innovation was the taking of moving pictures covering the details of the Triassic structures.

As previously announced, the undergraduate instruction in forestry at Cornell University is to be abandoned, and such work is to be concentrated in Syracuse University. Now it is officially stated that the Syracuse University College of Agriculture is to be discontinued.

THE Board of Estimate of New York City has

voted to set aside a plot of city-owned land in Manhattan Square, near the American Museum of Natural History, as a site for the museum's planetarium, a project to be financed through a Reconstruction Finance Corporation loan. The board stipulated that when the construction cost of the project is repaid through fees collected from the public, the property should revert to the city. The R. F. C. has approved a loan contingent upon the city's providing the site. Trustees of the museum recently organized an American Museum of Natural History Planetarium Authority to direct the project, naming the Mayor and other city officials to serve with officers of the museum.

THE sum of 2,000,000 kronas (about $400,000), has been bequeathed for the purpose of erecting a building for the Technical Museum of Stockholm by the "Knut and Alice Wallenberg Foundation," created by the Swedish banker, Knut A. Wallenberg, and Mrs. Wallenberg. The conditions attached to the donation are that the government should place building space at the disposal of the museum free of cost and that the work in order to reduce unemployment should be begun as soon as possible, in any case before the end of 1934. According to Science Service the Technical Museum of Stockholm is at present temporarily housed in the Royal Swedish Institute for Engineering Research, the head of which is Commercial Counsellor Axel F. Enström, one of its active supporters. The director, T. Althin, has gradually brought together a collection of objects and exhibits illustrating the origin, history and development of the present technical methods and inventions. The majority of these objects owing to lack of space has been stored in different parts of the city, but will now be exhibited in the new museum. It will be constructed in three stories with a floor space of about 8,000 square meters and will, when ready, be the leading institution of its kind in the north. It will also contain spacious lecture rooms and a library.

AN expedition to Guadelupe, an island belonging to Mexico and lying off the coast of Lower California, to hunt specimens of elephant seal, largest of all seals, for a proposed group to be installed at the Field Museum of Natural History, sailed from San Diego, California, on May 28. The expedition is being made aboard the yacht *Velero III,* a 1,000-ton ship about 200 feet long, owned and commanded by Captain G. Allan Hancock, of San Diego, who has placed the vessel at the disposal of the museum for this expedition. Captain Hancock and Dr. Harry M. Wegeforth, president of the Zoological Society of San Diego, have made all arrangements for carrying out the project. Two members of the Field Museum staff, Julius Friesser and Frank C. Wonder, joined the expedition at San Diego. The government of Mexico has issued permits to the expedition to collect the giant seals, which are rare and are under protection to prevent their extermination.

NINETEEN fellowships have been awarded by the New York State College of Forestry for the years 1933–34. Each scholarship carried a grant of $500. Two men have been given a one-semester award in order to complete their work. Six of the scholarships will be for a Ph.D. degree and the balance for master's degrees. These men are considered by the faculty to be especially qualified to take up advanced work. All recipients of the fellowships agree to give instructional assistance or do routine departmental work not to exceed fifteen hours a week. The holder of the fellowship is expected to devote his full time for the period of his appointment as outlined by the committee on scholarships.

Museum News states that the Newark, New Jersey, Museum has curtailed its activities as a result of a cut in the city appropriation from $100,000 to $65,000. Eighteen trained staff members and eight other assistants have been dropped from the rolls. Salaries have been cut 25 per cent. The lending work of the educational department, which last year made 32,000 loans of objects to Newark schools, has been discontinued, also the work of the extension department through which loans of small exhibits have been made to stores, churches and other organizations. The museum will be open to the public from 12 to 5 daily, except on Mondays. Daily gallery talks and the hobby work will be continued and the museum's activities centered on making as full use as possible of the museum building and equipment.

THE London *Times* reports that Dr. A. Maher, Keeper of the Irish Antiquities in the National Museum, Dublin, in the course of excavation work at Store Park, Ballyglass, County Mayo, on Saturday unearthed a stone cist, containing the skeleton of a man of powerful build, about 6 feet high. The find turned out to be a cist burial of the early Bronze Age, dating back 3,000 years. In the same cist a small clay-baked urn, which differs from any in the National Museum and is decorated with strange markings, was discovered. From the position of the bones it appears that the man was buried in a crouched position, the typical manner in which the dead were placed in Ireland during the Bronze Age. The skeleton and urn have been acquired for the National Museum, and will be scientifically examined in the near future. This is the second Bronze Age burial to be discovered in this neighborhood in the same week.

DISCUSSION

CONSERVATION VERSUS PRESERVATION

The Yellowstone Park Act of 1872 refers to "preservation from injury or spoilation of all timber, mineral deposits, natural curiosities or wonders within the park, and their retention in their natural condition." It was apparently considered illegal to carry on any "control" measures under the old law. The National Park Service Act, 1916, states that the purpose "is to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations." The Secretary of the Interior was further authorized to remove timber, control attacks of disease and insects and to provide for the destruction of such plant and animal life as may be detrimental to the use of the parks. This was very unfortunate legislation, as the confidence in beneficial results from such "control" has, since that time, materially weakened.

Many people conceive of the National Park Service as a conservation organization. To conserve, as the term is now most frequently used, means to preserve while in use and it often implies ultimate depletion. In actual practise the operations carried on in the name of conservation are not designed to preserve the natural order but to establish and maintain a different order as regards kind and abundance of plants and animals present. The difference between preservation is well illustrated in a recent publication by Wright, Dixon and Thompson,[1] who advocate the preservation of the birds and mammals in national parks. They point out the importance of dead timber to various birds and mammals, and the need of such timber for numerous invertebrates might well be added. Conservation as usually practised removes dead and mature timber, while preservation lets nature take its course.

In a series of suggestions by the authors mentioned nearly all the ordinary "conservation" views are reversed:

> Every species shall be left to carry on its struggle for existence unaided, as being to its greatest ultimate good, unless there is real cause to believe that it will perish if unassisted.
>
> No native predator shall be destroyed on account of its normal utilization of any other park animal, excepting if that animal is in immediate danger of extermination, and then only if the predator is not itself a vanishing form.

The authors of the report further advocate the encouragement of visitors to see animals; *e.g.*, bears in their natural surroundings rather than about a garbage pile.

The conservation idea may reasonably be extended to cover the preservation processes described in this recent publication. If so, one may conceive of the maintenance of exotic pheasants in South Dakota as very near the zero point of the conservation of nature with most other so-called conservation measures not far above this level. A nature sanctuary in a national park or national forest in which every effort was made to preserve a sample of original nature without disturbance may well stand at the top of the conservation series.

In nature sanctuaries the natural fluctuations of organisms are allowed free play and serve among other things to show what natural fluctuations in abundance are like. There is or has been so much interference with natural processes in the form of "control" of this and that organism that the student of "wild life" management who would seek a basis for more scientific treatment of the animals in his charge, is left without guiding principles or reliable information and will continue thus until the preservation measures advocated by Wright, Dixon and Thompson with additional measures of equal importance are put into effect in as many nature reserves as possible.

V. E. Shelford[2]

NOTES ON A SPHAGNUM BOG AT FORT BRAGG, CALIFORNIA

The farthest south sphagnum bog which the writer has seen on the Pacific Coast is located about three miles east of Fort Bragg, which is on the coast, about 125 miles north of San Francisco. It is from 200 to 400 feet or more in width and is perhaps three fourths of a mile long. The bog occupies an irregular depression in a flat about 300 feet above sea-level. A creek originates in the bog and flows into the Noya River which flows into the ocean at Fort Bragg. The soil of this flat is almost pure sand known as Mendocino sand.

The bog is in a young stage of development in which the aspect is mainly given by *Ledum columbianum*, forming a dense growth four or five feet tall, and a large sedge (*Carex* sp.) which is a little taller than the Ledum and is equally abundant. Scattered *Myrica californica*, mostly five to ten feet tall, occurs much as in the bogs of the Oregon coast, and a low growth of *Gaultheria shallon* is also found. A robust species of *Sphagnum* forms a dense growth among the *Ledum* and *Carex* and forms many hummocks. The herbs identified are *Drosera rotundifolia*, *Hypericum anagalloides*, *Lilium maritimum* and *Gentiana* sp.

[1] "Fauna of the National Parks of the United States," Contribution of Wild Life Survey Fauna Series 1, 1933.

[2] Chairman of the Committee on the Preservation of Natural Conditions, Ecological Society of America.

The forest succession comprises small scattered trees of the three species—*Cupressus pigmya, Pinus muricata* and *Pinus contorta*. The first of these is the dominant one, though the last one shows occasional larger individuals (30 feet or more tall). Young specimens of the dominant tree (3 feet or less in height) are as abundant as the older ones (20 feet or more in height).

The plant community surrounding this bog is a scrubby forest of small trees (mostly 40 feet or less in height) forming a dense growth. It is largely *Cupressus pigmya,* but there is some *Pinus contorta* and an occasional specimen of *Pinus muricata*. The shrubby undergrowth in this forest is largely *Myrica californica, Ledum columbianum* and *Gaultheria shallon*. The first two of these grow much taller in the forest than in the bog. Herbs occurring in both forest and bog are *Lilium maritimum* and *Gentiana* sp. This forest forms a belt about two miles wide on the level stretch of Mendocino sand. Back of this is the redwood forest on good soil.

Borings made in this bog near the origin of the creek show three strata of peat. (a) A surface layer of living sphagnum, under which is dead sphagnum, little disintegrated and much mixed with roots of *Ledum* and *Carex*. This layer of living and dead sphagnum is mostly 12 to 18 inches deep. (b) A layer of sedge peat with many small roots and some wood. The depth of this layer is mostly 1.5 to 2 feet. (c) A mixed layer of mud clay, sand and wood about 4 feet deep. The wood in this layer, like that in (b), is in a fairly good state of preservation. The boundaries between these layers are not very distinct. The borings were made with a Davis peat borer, and the large amount of wood encountered made sampling very difficult.

Evidently this bog has been formed in a relatively flat, shallow ravine by a dense growth of sedges and other swamp vegetation on the accumulated mud, sand, clay and remains of woody plants. The sphagnum is a comparatively recent invader. Drainage in this bog is better than that in most Pacific Coast bogs and this may account in part for its lack of maturity.

Fort Bragg has wet winters and dry summers. The average monthly and annual precipitation in inches (37 years' record) is as follows: January, 7.71; February, 6.89; March, 4.89; April 2.45; May, 1.49; June, 0.42; July, 0.08; August, 0.04; September 0.81; October, 1.80; November, 5.01; December, 6.11; annual, 37.70. The only snow reported during the last 17 years is 1.0 inch in January, 1923. No temperature data are available for Fort Bragg, but the 45 years' record at Eureka to the northward shows an average of 51.40° F. and the 41 years' record of Pt. Reyes of 52.5° F. The monthly data for Eureka are as follows:

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Average ...	47.1	47.6	48.4	50.0	52.2	54.5	55.7	56.2	55.7	53.6	51.1	47.8
Highest ...	77	85	78	79	78	85	76	79	82	84	81	70
Lowest	20	24	29	31	35	40	43	45	36	35	27	24

The maximum recorded at Pt. Reyes is 98° (September) and the minimum 30° (March). All the above data were furnished by the U. S. Weather Bureau office at San Francisco.

The character of this bog is of interest in the general problem of the occurrence and course of development of sphagnum bogs along the North Pacific Coast of America. It is reported that sphagnum forms considerable growths at various points in the forests of the coast of northern California, but detailed information about bogs formed by it is not available. This bog has much in common with the coastal bogs of Oregon, though it has not reached the somewhat mature stage shown by many of the Oregon bogs. Its forest succession resembles that in bogs of Oregon and Washington in including *Pinus contorta* but differs strikingly from them in the occurrence of *Cupressus pigmya*. The climatic conditions under which it has developed do not differ greatly from those under which the bogs of Western Oregon and Washington have developed.

The writer made his study of this bog on August 26, 1931. His first information in regard to it was received from Mr. W. G. Corbitt, and valued assistance in its study was given by Mr. V. B. Davis. He will welcome further information in regard to the occurrence of sphagnum areas in California.

GEORGE B. RIGG

UNIVERSITY OF WASHINGTON, SEATTLE

SEDIMENTATION AND SEDIMENTOLOGY

THE terms "sedimentology" and "sedimentation" are subjects of comment by W. H. Twenhofel in the *Bulletin of the National Research Council,* Report of the Committee on Sedimentation, 1930–1932, p. 18. Dr. Twenhofel considers the terms "sedimentation" and "sedimentationist" as more fitting designations than "sedimentology" and "sedimentologist" for "the range of geologic processes concerned in the formation of the sedimentary rocks" and for "a student of sediments," respectively. He rejects "sedimentology" because it contains "roots from two languages."

The choice of terms is perhaps not of great importance for the present. It has seemed advisable, however, to reconsider the question, because, whatever term is now adopted, it will be difficult to change when once entrenched in the literature.

First, a minor correction of Dr. Twenhofel's statement is needed. In my article "Sedimentation and Sedimentology," in SCIENCE of January 1, 1932, "sedimentology" was not proposed as a designation for "the range of geologic processes concerned in the formation of the sedimentary rocks," but as a designation for the subject concerned with these processes.

The term "sedimentology" had previously been so rarely used in geological literature (3 or 4 times), that I believe most geologists were not aware of its existence. After my article appeared in SCIENCE in January, 1932, I learned that the term "sedimentology" was first introduced some ten years ago by Dr. A. C. Trowbridge, who, in "American Men of Science," has listed sedimentology as one of his major subjects.

Etymologically hybrid formations are not uncommon. In my earlier article in SCIENCE, glaciology was mentioned as an analogy to sedimentology. "Sociology," "vulcanology" and "stratigraphy" are hybrid formations which in the past have been used without objection. Since "terminology" itself is a Latin-Greek formation, there seems to be no reason for disqualifying the term "sedimentology," especially since the latter, in the interest of non-ambiguity and logical consistency, is superior to "sedimentation" as a term for the subject. Hybrid formations are also frequently found in the German language, which permits such combinations as *Sedimentgesteine, Sedimentpetrographie,*" etc.

All standard dictionaries state that sedimentation is an act or process of depositing sediments. The use of the term "sedimentation" also for the subject concerned with processes of sedimentation and formation of sediments, ancient or recent, is a violation of the principle of non-ambiguity, and is therefore more objectional than the use of a hybrid formation. There is a distinct difference between the glaciation of North America and the glaciology of North America, or better, the glaciation of Greenland and the glaciology of Greenland. In analogous manner, differentiation should be made, for instance, between the sedimentation of the Mexican Gulf and the sedimentology of the Mexican Gulf.

The choice between "sedimentologist" and "sedimentationist" as designations for a student of sediments is not entirely a matter of taste. The terms "Vulcanist" and "Neptunist" designate two old schools of geologists, *i.e.,* these terms signify advocates or assertors of certain theories rather than students of certain subjects. The sole ending *-ist* does not always signify a student or one versed in a particular subject. There is generally a difference between a socialist and sociologist, a symbolist and symbologist, an idealist and ideologist. Generally, the ending *-logy* signifies a theoretical, scientific, analytical, philosophical study, and the ending *-logist* usually denotes a student or one versed in the subject.

Another objection to "sedimentation" is that it does not readily permit the formation of derivatives corresponding to "sedimentologic" and "sedimentological." These adjectives are useful for such expressions as "sedimentological (or "sedimentologic") research," "sedimentological investigations," "sedimentological theories," etc.

In conclusion, retention of "sedimentation" for the act or process of deposition of sediments, and adoption of "sedimentology" as a term for the subject concerned with these processes will tend toward clearness. A new term entirely of Greek composition is not likely to be accepted.

"Sedimentography" is herewith introduced as an additional term signifying the descriptive branch of sedimentology, *i.e.,* that part which deals with the minute phases, megascopic and microscopic features, textures and classification.

HAKON WADELL

MECHANICISM, VITALISM AND THE GROWTH OF BACTERIA

MUCH has been written about the chemical nature of growth, and in this connection unicellular and higher cold-blooded organisms have received especial attention. The fact that the rate of growth, metabolism and activity of such organisms increases with a rise of temperature, to the optimum, in a similar manner to the thermal acceleration of a chemical reaction, has justly received emphasis.

It is not the intention of this note to detract from the progress which has been made toward the explanation of life processes on purely physical and chemical bases. Least of all would we wish it to be considered as a partisan contribution to that threadbare discussion of "vitalism" and "mechanism." After all, it is probable that most of the functions of living matter which can not now be accounted for physically or chemically are obscure simply because of the deficiencies in our scientific conceptions.

Bacterium coli grows actively at 45° C. and also at 10° C., the rate of reproduction being about thirty times as fast at the higher temperature. It is known that actively growing bacteria continue to grow at the same rate when transferred to sterile medium of the same composition. On purely chemical grounds one would expect that if a transfer were made from an actively growing culture at 10° C. to sterile medium of the same composition at 45° C., growth should immediately be accelerated to the rate characteristic of a culture growing at this temperature. This, however,

is not the case. Such a treatment induces a "lag" before growth of the culture can again proceed, and some of the cells die before the adjustment is made. Within one hour, however, reproduction is under way at a rate characteristic of a 45° C. culture.

If an actively growing culture at 45° C. is transferred to sterile medium of the same composition at 10° C., more striking results are obtained. In this case there occurs an extensive mortality among the young bacterial cells—sometimes exceeding 95 per cent. of the total. As is well known, such a drop in temperature has no effect upon "mature" bacterial cells.

A fact brought out by these experiments, which is perhaps new and certainly not generally appreciated, is that abrupt environmental changes within the range of growth of an organism may prove lethal to the young of the species. The "hardening" of young greenhouse plants by subjecting them to low temperatures, so they may later survive freezing, is a practise which rests on conclusive experimental data. But that environmental fluctuations within the natural range of growth may be fatal to the young organism has not been so clear.

A point of more interest is the fact that the young bacteria growing at 10° C. are not so extensively killed when changed to 45° C. as are those growing at the higher temperature when changed to the lower. This indicates a greater hardiness in those grown at the lower temperature. That this is indeed the case has been proved by other methods.

The experiments on which this communication is based constitute a part of a series which was planned in order to test a hypothesis, long held by us, that slow growth should lead to a more perfect adjustment of an organism to its environment and, therefore, to greater viability. While the greater viability of the cells grown at low temperatures, as compared with those grown at higher temperatures, has been established, it is not conclusively proved that the difference is due to the slower growth rate. Proof of this point would convey broad implications.

JAMES M. SHERMAN
GEORGE M. CAMERON

CORNELL UNIVERSITY

REPORTS

HONORS CONFERRED BY THE FRANKLIN INSTITUTE

AT the Medal Day exercises of the Franklin Institute of the state of Pennsylvania, held in the hall of the institute in Philadelphia on the afternoon of Wednesday, May 17, fourteen honors which had been awarded during the institute year were presented to their recipients or representatives of them. The medalists were drawn from three foreign countries as well as from the United States. The awards were as follows:

A certificate of honorary membership was presented to Mr. Alfred Rigling, of Philadelphia, Pennsylvania, in recognition of a half century of helpful and intelligent service as librarian and assistant secretary of the Franklin Institute, during which long term of duty well done he has been a pillar of strength to the institute, a source of comfort to the discouraged and of knowledge to the ignorant, a librarian amazingly informed concerning his library and a kindly gentleman skilful and eager in friendly service to his fellow men.

A certificate of merit to Dr. Henry Selby Hele-Shaw, of London, England, in consideration of his development of a superior filtering device involving stream-line principles. The British consul, Mr. Frederick Watson, received the certificate.

A certificate of merit to Mr. Arthur F. Poole, of Ithaca, New York, in consideration of his combination in a battery-operated clock, of known mechanisms, that has produced a clock in which the swing of the pendulum is the driving force of the gears controlling the hands, and also determines the frequency of the impulse, that requires battery renewal at long intervals only and that is an accurate time-keeper.

The fourth presentation of the day was that of an Edward Longstreth Medal—founded in 1890 by Edward Longstreth, of Philadelphia—to Mr. Howard L. Ingersoll, of the New York Central Lines of New York City, in consideration of his development of the locomotive booster to a state in which it gives valuable aid to locomotive performances and railroad service.

A second Longstreth Medal was presented to Dr. Dunlap Jamison McAdam, Jr., of the Bureau of Standards, Washington, D. C., in consideration of the fact that Dr. McAdam has provided information that satisfactorily explains certain structural failures, has developed formulae and diagrams to illustrate the complex relationship of the influences of stress on corrosion, and has done more than any one else to establish the fundamental principles of corrosion fatigue, coupled with the fact that the information provided has already been usefully applied and should have wide future practical application.

Three John Price Wetherill Medals—founded in 1925 by the family of the late John Price Wetherill—were next presented: the first to Messrs. Henry S. Hulbert, Francis C. McMath and Robert R. McMath,

of the McMath-Hulbert Observatory of the University of Michigan, Lake Angelus, Michigan, in consideration of their design and construction of novel apparatus for the making of motion pictures of astronomical subjects, which have proven of value in the teaching and popularization of astronomy.

A Wetherill Medal was presented to the Industrial Brownhoist Corporation, of Bay City, Michigan, in consideration of the high degree of ingenuity in design and execution of detail, embodied in a successful machine for cleaning railway ballast resulting in a real contribution to railroading and the solution of a maintenance problem of great moment, especially under traffic conditions of extreme density.

The Wetherill Medal was presented to the Koppers Company of Delaware, of Pittsburgh, Pennsylvania, in consideration of the development of systems for the liquid purification of gases, the success of which is evidenced by the number of such installations in regular use.

A Louis Edward Levy Medal—founded in 1923 by the family of Louis E. Levy, of Philadelphia—was next presented to Mr. Leon S. Moisseiff, of New York City, for his paper entitled "The Design, Materials and Erection of the Kill Van Kull (Bayonne) Arch," published in the May, 1932, issue of the *Journal* of the Franklin Institute.

A George R. Henderson Medal—founded in 1924 by the widow of George R. Henderson, of Philadelphia—was presented to Mr. Otho C. Duryea, of the O. C. Duryea Corporation of New York City, in consideration of the meritorious railway engineering and the novel feature embodied in the invention of the Duryea Railway Car Cushion Underframe.

The Howard N. Potts Medal—established in 1906, by will of Mr. Potts, a Philadelphia lawyer—was awarded to Mr. Igor I. Sikorsky, of the Sikorsky Aviation Corporation of Bridgeport, Connecticut, in consideration of his pioneer work and inventions in the development of multi-motored airplanes of various types, for different uses, including amphibians and the largest combined planes for land and water service, and of his method of direction control of a multi-motored machine by the use of an automatic stabilizer.

One Elliott Cresson Medal—founded in 1848 by Mr. Elliott Cresson, who was very much interested in the work of the Franklin Institute, this award being highly prized and next to the Franklin Medal in importance—was awarded this year to Señor Juan de la Cierva, of London, England, in consideration of the original conceptions and inventive ability which have resulted in the creation and development of the autogiro.

The Franklin Medal was founded in 1914 by Samuel Insull, Esq., of Chicago, Illinois, a long-time member and friend of the Franklin Institute. This medal is to be awarded to those workers in physical science or technology, without regard to country, whose efforts, in the opinion of the institute, have done most to advance a knowledge of physical science or its application.

The Franklin Medals are awarded each year, usually to an outstanding scientist of the United States and to some scientist from some other country. This year the first Franklin Medal was awarded to Dr. Orville Wright, of Dayton, Ohio, in recognition of the valuable investigations carried out by him and his brother, Wilbur, from which they obtained the first reliable scientific data concerning the principles of flight and the design of aeroplanes, upon which they constructed the first heavier than air machine which flew by its own power under human control.

The second Franklin Medal was awarded to Dr. Paul Sabatier, dean of the Faculty of Science of Toulouse University, Toulouse, France, in recognition of his numerous and fruitful contributions to the general field of chemistry and especially to organic chemistry, in which he discovered the catalytic activity of finely divided common metals and devised methods for their use in science and industry. Dr. Sabatier was unable to come to America to receive his medal in person. He was represented by the councillor of the French Embassy in Washington, Monsieur Jules Henry.

On the evening of Medal Day, the Franklin Institute held a dinner at the Bellevue-Stratford Hotel in honor of the medalists of the day. About seventy-five guests were present.

SOCIETIES AND MEETINGS

THE OHIO ACADEMY OF SCIENCE

The forty-third annual meeting of the Ohio Academy of Science was held on April 14 and 15, on the beautiful campus of historic Ohio University, Ohio's oldest university, at Athens, Ohio. To the surprise of many the attendance was probably the largest in the history of the academy, there being some 360 registered members and visitors, besides quite a few who forgot to register.

This meeting concluded the presidency of Dr. R. A. Budington, Oberlin College, Oberlin, Ohio, the two outstanding events of whose very successful administration were the formation of a new section, namely, a section of chemistry, under the inspiration and leader-

ship of Dr. William Lloyd Evans, of Ohio State University, and the sponsoring by the academy of a series of radio talks by members of the academy on various popular scientific topics, made possible through the courtesy of the broadcasting station WEAO at Ohio State University, Columbus.

The general meetings of the academy were favored with four interesting lectures, one on the evening of the 13th by Professor F. J. Roos, of Ohio University, on "Architecture in Ohio"; two on Friday morning, one by Dr. F. C. Waite, of Western Reserve University, on "The Early History of the Microscope" and the other by Dr. S. Charles Kendeigh, of the Baldwin Bird Research Laboratory and Western Reserve University, on "Toleration of Low and High Temperatures by Birds." The fourth was the presidential address given before an overflowing audience on Friday evening at the annual dinner by President Budington on "The Innocence and Guilt of Science." In addition to these general lectures, some 145 papers were read in the eight sectional meetings held on Friday and Saturday, some by distinguished scientists from outside of the state. The attendance at these sectional meetings was very large, in some instances overtaxing the capacity of the meeting place. The demonstrations and exhibits were unusually interesting and elaborate, notably the exhibit of insects of southeastern Ohio.

The organization of a section of chemistry and the presence of a large number of eminent chemists from the leading universities and colleges of the state added much to the success and importance of the meeting. We also note with pleasure the presence of a large number of members of the Central Ohio Physics Club, Professor G. E. Owen, of Antioch College, president.

The following members of the academy were elected to fellowship in the academy, *viz.:* David Dietz, Rush Elliott, Robert A. Kehoe, Roderick Peattie, and William C. Stehr.

At the final business meeting on Saturday morning, 24 new members were received into the academy, and the election of officers for the coming year resulted as follows:

President, Dr. E. Lucy Braun; *Vice presidents—zoology,* Neale F. Howard; *botany,* Orville T. Wilson; *geology,* William A. P. Graham; *medical sciences,* Robert A. Kehoe; *psychology,* Richard S. Uhrbrock; *physics and astronomy,* Ray Lee Edwards; *geography,* Roderick Peattie; *chemistry,* William Lloyd Evans; *Secretary,* William H. Alexander; *Treasurer,* A. E. Waller; *Elective Members Executive Committee,* R. A. Budington and James P. Porter; *Trustee Research Fund,* Alpheus W. Smith; *Publications Committee,* F. O. Grover, J. E. Carman and S. W. Williams; *Library Committee,* F. C. Blake; *Committee on State Parks,* Edmund Secrest, H. C. Sampson and Emery R. Hayhurst; *Save Outdoor Ohio Council,* Herbert Osborn and E. N. Transeau.

It is worthy of note that this is the first time in the history of the academy that the academy has honored itself by the election of a woman as its president.

W. H. ALEXANDER,
Secretary

THE ILLINOIS STATE ACADEMY OF SCIENCE

THE twenty-sixth annual meeting was held at the Broadview Hotel and Senior High School, East St. Louis, Illinois, on May 5 and 6. The meeting was attended by nearly 700 persons, including about 150 high-school students, members of high-school science clubs affiliated with the junior section of the academy.

General addresses were given by: Harry F. Ferguson, president of the academy and chief sanitary engineer, State Department of Public Health, on "The Future of the Illinois Academy of Science"; Dr. M. B. Visscher, professor of physiology, University of Illinois College of Medicine, on "Medical Science, its Past, Present, and Future"; Dr. Frank J. Jirka, director of the State Department of Public Health, on "Advances in the Science of Public Health"; Dr. Harry R. Hoffman, director, Behavior Clinic of the Criminal Court of Cook County, on "Psychiatry in the Criminal Courts of Cook County."

There were 105 scientific papers on the program in 10 sectional meetings. The program of the agriculture section, arranged by H. W. Mumford, dean of the College of Agriculture, University of Illinois, was a symposium on the subject, "Problems of the Soybean Industry." The economics section, under the direction of W. H. Voskuil, mineral economist, Illinois State Geological Survey, held a symposium on "Problems of the Illinois Coal Industry."

Six field excursions were held on Saturday, May 6: (1) An anthropological trip to the Cakokia Mounds State Park, under the direction of A. R. Kelly, University of Illinois; (2) a botanical trip to the Missouri Botanical Gardens, directed by H. S. Pepoon, State Natural History Survey; (3) a chemical trip to the Monsanto Chemical Works, directed by Percy J. Hill, East St. Louis; (4) a geographical trip to study the water factors in the geography of the East St. Louis district, directed by Lewis F. Thomas, Washington University, St. Louis; (5) a geological trip, directed by M. M. Leighton, chief, Illinois State Geological Survey, to study the coal measures and glacial geology of the East St. Louis district, the Dupo anticline and oil field, and the limestone mine on the Valmeyer anticline; and (6) a physics trip to the Cahokia Power Plant.

The following resolution was adopted by the academy:

I. *Whereas*, this Academy has at an earlier meeting adopted resolutions concerning the establishing of National Forest units in the State of Illinois, be it resolved that the academy assembled in Annual Meeting on May 5th, 1933, reaffirm its interest in and active support of a policy looking toward the development of forestry conservation within our state. Be it further reaffirmed that this Academy stands ready to offer its support to both State and Federal Agencies in furthering the establishment of adequate programs of forest conservation.

II. As a body of more than one thousand persons interested in science, the Illinois State Academy of Science takes this opportunity to affirm its interest in and concern for the welfare of all scientific work of the various state agencies. Be it therefore

Resolved, that this body go on record endorsing the past and projected programs of research and studies carried on by the various educational institutions, scientific surveys and other research organizations under state direction. Be it further *Resolved* that the State Legislature be urged to continue to extend adequate financial support to these organizations. Further be it *Resolved* that the Legislative Committee of this Academy be instructed to work for all matters of legislation favoring these agencies and to oppose all untoward legislation threatening the progress of education and of science in the State.

The following were chosen officers for the year 1933–34:

President: B. Smith Hopkins, chemistry, University of Illinois.

First Vice-president: Charles H. Behre, geology, Northwestern University.

Secretary: Harold R. Wanless, geology, University of Illinois.

Treasurer: George D. Fuller, botany, University of Chicago.

Editor: Dorothy E. Rose, State Geological Survey, Urbana.

It was decided to hold the twenty-seventh annual meeting of the academy at Decatur early in May, 1934. Dr. J. H. Ransom, of James Millikin University, will serve as chairman of the committee on local arrangements.

Harold R. Wanless,
Secretary

THE VIRGINIA ACADEMY OF SCIENCE

The Virginia Academy of Science held its eleventh annual meeting at the State Teachers College, Fredericksburg, Virginia, on May 5 and 6, with a registration of 320. In the section of astronomy, mathematics and physics 27 papers were presented; in biology, 37; in chemistry, 17; in geology, 15; in the medical sciences, 15; and in psychology and education, 12, making a total of 121.

The annual prize of fifty dollars was awarded to S. A. Wingard, of the Virginia Polytechnic Institute, for a paper entitled, "The Production of Rust-Resistant Varieties of Beans by Hybridization," and honorable mention was accorded to a paper by A. N. Vyssotsky and Emma T. A. Williams entitled "Color Indices and Integrated Magnitudes of Fifteen Bright Globular Clusters." These awards carry added significance this year because of the unusually high quality of the papers in competition with them.

The research committee reported that during the year the following grants in aid of scientific research had been made: Jesse W. Beams, physics, University of Virginia, $150; J. C. Forbes, biochemistry, Medical College of Virginia, $75; J. M. McGinnis, psychology, Hollins College, $40; C. C. Speidel, anatomy, University of Virginia, $100; N. Beverly Tucker, chemistry, Virginia Military Institute, $50; I. A. Updike, chemistry, Randolph-Macon College, $75.

A noteworthy item in the year's work is the increase in the number of junior (or student) members, the number having increased from 54 to 115. There were also two papers presented by junior members and two exhibits of their work were shown. One was an array of totally cleared anatomical and zoological specimens and the other was an inexpensive, laboratory-built apparatus for the fixation of atmospheric nitrogen.

Dr. William A. Kepner, of the University of Virginia, was elected president for the coming year, Dr. William T. Sanger, of the Medical College of Virginia, president elect, and Professor D. Maurice Allan, of Hampden-Sydney College, member of the council.

Following the meeting rather extensive field trips were made by the committee on the flora of Virginia and by members of the geology section.

E. C. L. Miller,
Secretary

THE TENNESSEE ACADEMY OF SCIENCE

The thirty-second meeting of the Tennessee Academy of Science was held at the Reelfoot Lake Biological Station of the academy on April 28 and 29. The feature of the meeting was an address by The Very Reverend I. H. Noe, dean, St. Mary's Episcopal Cathedral, Memphis, in dedication of the John T. McGill Laboratory Building. This building is named in honor of Dr. John T. McGill, professor emeritus of chemistry at Vanderbilt University and secretary-treasurer of the Tennessee Academy of Science. In thus dedicating this building recognition is given to Dr. McGill of his many years of valued work in and for the academy and particularly of his efforts which resulted in the establishment in 1931 by the state of

Tennessee of the Reelfoot Lake Biological Station under the management and control of the Tennessee Academy of Science. The John T. McGill Laboratory is a modernly equipped building containing four laboratories fitted with proper work tables, cabinets, aquaria, etc., several stock and preparation rooms, and a large assembly room. This laboratory, located on the east side of Reelfoot Lake in Obion County, lies in a region which represents well the water and land fauna and flora of the Mississippi bottom. It is a few minutes walk from the comfortable Walnut Log Lodge, where special rates are available for workers at the laboratory. It is the policy of the executive committee of the station to allot free working space in the laboratory for research work of scientific interest. Application should be made to Dr. A. R. Bliss, Jr., University of Tennessee Medical School, Memphis, Tennessee.

In addition to the dedicatory exercises, approximately thirty papers were presented during four sessions of the meeting. These interesting programs were composed of reports on research work on diversified subjects and were presented by representatives of the following institutions: The University of Tennessee, Memphis; Southwestern University; George Peabody College; Vanderbilt University; Tennessee Department of Public Health; U. S. Department of Agriculture; Lambuth College; West Tennessee Teachers College; Freed-Hardeman College; University of Tennessee Junior College, Martin; State Teachers College, Murfreesboro. Numerous groups made field excursions both on the lake and into the surrounding woodlands for the collection of specimens and material from this interesting territory. These trips and the congenial atmosphere of the Walnut Log Lodge contributed not a little to the success of the meeting. The academy is indebted to Dr. A. R. Bliss, Jr., and his committee on arrangements for making possible one of the most pleasant and successful of the academy meetings.

FRANCIS G. SLACK,
President

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A TELEPHONIC DROP COUNTER

THE drop counter here described operates on the mechanical contact principle, but uses a telephone transmitter as the contact mechanism in place of the conventional metal vane making contact in a pool of mercury. The small current variations of the transmitter are amplified by a powerful vacuum tube relay, which gives a large current output sufficient to operate any type of recording apparatus.

Fig. 1 represents a Western Electric telephone

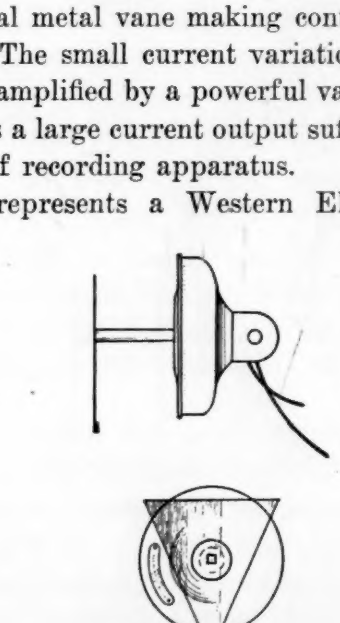

FIG. 1. Transmitter with vane attached to diaphragm.

transmitter with the rubber mouthpiece removed. A triangular vane of thin mica or celluloid, about 5×7 cm, is fastened at its center to a light celluloid spindle some 7 cm long, and the lower end of the spindle is cemented to the diaphragm of the transmitter with celluloid-acetone cement. The vane is mounted parallel to the diaphragm and about 5 cm above the top of the transmitter to allow a layer of sound-deadening cotton to be spread over the transmitter. The transmitter is laid in a boxful of cotton to prevent outside vibrations from actuating the mechanism, and the pipette is adjusted so that the drops fall on the vane.

Fig. 2 shows the electrical system used to amplify

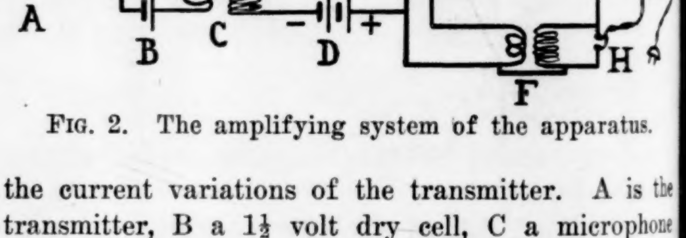

FIG. 2. The amplifying system of the apparatus.

the current variations of the transmitter. A is the transmitter, B a $1\frac{1}{2}$ volt dry cell, C a microphone transformer with a 60 to 1 ratio between secondary and primary, D the bias battery of 9 volts made of two $4\frac{1}{2}$ volt C-batteries in series, E is the amplifying tube, F the filament supply transformer, G the output connections and H the 110 volt supply leads.

The amplifying tube is a General Electric Thyratron FG-17, a mercury ionization vacuum tube of peculiar properties which operates on raw 110 volt alternating current and requires no B-battery. In this device the plate current does not follow the grid voltage up and down as in the ordinary amplifying tube, but no plate current at all flows until the grid voltage reaches a certain value, when the mercury vapor suddenly ionizes and an output of about 50 watts results. The tube consequently is an excellent

off-and-on relay, and is well adapted to many recording and controlling processes in the laboratory. The output is half-rectified alternating current, which operates most direct current magnets satisfactorily. The tube fits an ordinary 4-prong radio tube socket, but the plate connection is made to the metal knob on top of the tube instead of the plate contact on the base. Filament current at 2.5 volts and 5 amperes is supplied by a small transformer to be had at any radio supply store, and no rheostat is necessary. The output circuit of the tube should contain a 50 ohm resistance to limit the current flow to 0.5 ampere in case of a short circuit, since the filament can be ruined by excessive current passed through the tube.

In operation the current to the Thyratron is turned on, and the tube allowed to heat for 3 or 4 minutes until the contained mercury is vaporized. The microphone battery is then connected and the apparatus is ready to work. As the current through the transmitter and primary of the transformer may amount to 25 milliamperes, the microphone battery should be disconnected when not in use, and for long runs one 2-volt cell of a storage battery may be used for economy's sake. There are no adjustments to be made when the apparatus is in operation. The response of the Thyratron to each drop can be made longer or shorter by a decrease or increase in the negative bias impressed on the Thyratron grid by the bias battery D, so that the length of time the current continues for each impulse can be set for the inertia of the moving parts in any recording apparatus. The value of 9 volts for the bias battery is an average which will give a quick magnet response to drops falling as rapidly as they can without coalescing into a stream.

The apparatus is not at all critical in its adjustment; in fact, the transmitter has a great excess of sensitivity, and with its normal battery voltage of 4.5 volts and a small negative bias in the grid circuit will operate the Thyratron when a sheet of paper is rustled before the uncovered mouthpiece. The wires from the transmitter to the amplifying set and the wires of the output circuit can be made of any convenient length, since moderate resistance or capacity affects these circuits but little. It is convenient to mount the pipette at the edge of a table and let the drop fall about 30 inches to the transmitter resting on the floor.

The use of the apparatus is not confined to drop counting, but it can be adjusted to make a record of the fall of any body large enough to shake the diaphragm. When adapted to sound recording by an increase in the sensitivity of the transmitter, it can be used to pick up the ticks of a pendulum and send out time signals, to respond to a single note when the transmitter is placed in a tuned resonator, to record sounds in general, or to operate mechanical devices at a definite level of sound-intensity. Laboratory workers may find the apparatus useful in ways not contemplated in the present application.

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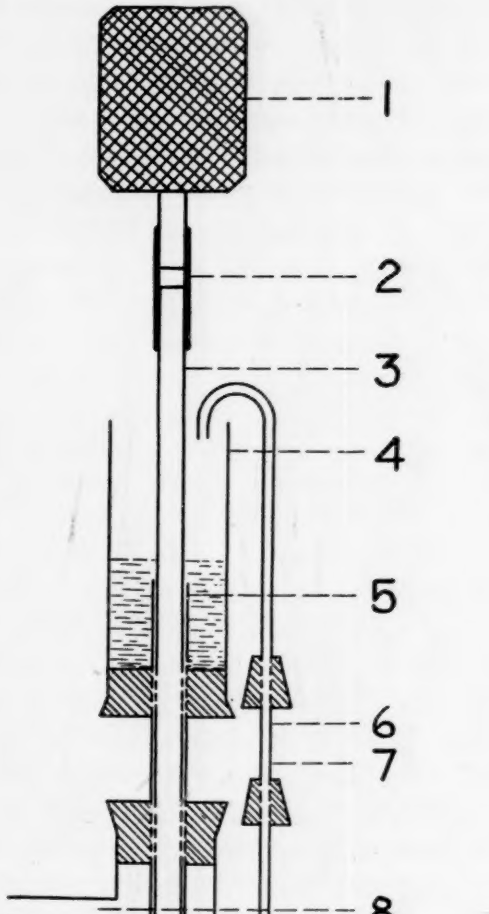
A DISINTEGRATOR FOR YEAST CELLS

A SIMPLE device to break up yeast cells is desirable in order to obtain certain growth-promoting factors which are not available without rupture of the cell wall. Such an apparatus can be made from glass rod and tubing with a few rubber connections and a suitable motor. The accompanying diagram shows the structure of the apparatus.



A rather concentrated suspension of yeast placed in the reservoir (4) flows by gravity through a long bearing (5) in which a vibrating shaft (3) is revolv-

ing. As the material drops from the bearing into the receiver (9), it is transported by a current of inert gas through a return tube (7) to the reservoir (4) from which it may again flow between the shaft and bearing. This continuous circulation and regrinding is maintained until an examination of the material in the reservoir by the hanging drop or Gram stain methods shows that sufficient disintegration has occurred.

A number of details are essential to the success of the operation. A smooth bearing and shaft running without vibration at high speed have very little effect on the yeast cells. The surfaces of the bearing and shaft must be roughened by rubbing them with moist carborundum powder (100 mesh) before assembling the apparatus. About 0.1 g of the abrasive is added to 20 cc of suspension to insure keeping these surfaces rough. Vibration is produced by a vibrating joint. The occasional addition of a drop of octyl alcohol to prevent foaming is sometimes very effective in securing a relatively high concentration of the desired factors. Pyrex glass is used throughout to avoid the marked change in acidity which is caused by soft glass and to increase the life of the apparatus. It is desirable, although not essential, to permit the bearing to project part way into the liquid in the reservoir. An opening blown in this tube just above the stopper prevents any dead space. A current of nitrogen, air or other suitable gas is passed through a bubble counter and humidifier containing distilled water. A convenient rate is 3 to 5 bubbles per second; but when the shaft and bearing have become worn, a more rapid rate may be desirable to prevent the formation of any considerable column of liquid in the return tube. If gas bubbles up between the shaft and bearing, either the clearance between the two is too great or the current of gas has not been rapid enough to prevent accumulation of fluid in the receiver and return tube. The motor is run at 3,000 to 4,000 r.p.m.; the speed depends somewhat on the action of the vibrating joint, which should not become violent enough to damage the bearing.

The average length of run has been five hours. Examination showed that 50 to 75 per cent. of the cells had disappeared within 90 minutes and 90 per cent. in 300 minutes. The disintegration is most efficient with the more concentrated suspensions, since the rate at which the cells are ruptured depends apparently on the probability of a cell being pinched between the rotating, vibrating rod and the rough bearing surface. After centrifugation and filtration through a Berkefeld filter, the turbid sterile filtrate is used without undue delay. The apparatus may be used for disintegration of other biological materials and for securing intimate contact and mixing in chemical reactions involving combination of a gas with a suspended solid where continuous exposure of new surface is desired.

Explanation of the Diagram

The dimensions given are those of an apparatus which gave consistently satisfactory results, but there is no apparent reason why many of them could not be altered: (1) Motor—a "Sew motor" with its rheostat was used; (2) vibrating joint: a 2 inch length of glass tubing connected securely to the shaft of the motor with rubber tubing and to (3) with a two inch length of heavy rubber tubing; (3) disintegrator shaft, a straight rod or capillary tube 27 cm by 7.8 mm; (4) reservoir, a 12 cm by 3 cm glass tube attached to the bearing by a number 6 rubber stopper; (5) bearing, a straight tube 22 cm by 10 mm outside diameter, wall thickness, 1 mm; (6) return tube in three sections, 3 mm outside diameter; (7) gas outlet, identical with (6); (8) gas inlet; (9) receiver, constructed from a 6 x ¾ inch side arm test-tube either by sealing a 17 cm section of the return tube to the base as illustrated, or (10) by cutting off the base of the tube smoothly, flanging the edge, and using a number 4 stopper to connect the return tube.

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SPECIAL ARTICLES

THE DEVELOPMENT OF ORGANIZED VESSELS IN CULTURES OF BLOOD CELLS

IN an experiment in which blood cells were placed for incubation in culture flasks containing a mixture of blood plasma and Tyrode solution, the usual technique for the cultivation of the leucocytes[1] was slightly modified in that coagulation was allowed to take place spontaneously and without the customary addition of embryonic tissue juice. Later, the cultures were found to contain numerous, highly organized, tubular processes that projected out from the original explant. A year ago, Hueper and Russell[2] reported

[1] A. Carrel and A. H. Ebeling, "Pure Cultures of Large Mononuclear Leucocytes," *Jour. Exp. Med.*, 36: 365, 1922.

[2] W. C. Hueper and M. A. Russell, "'Capillary-like Formations' in Tissue Cultures of Leucocytes," *Arch. f. exp. Zellforschung*, 12: 407, 1932.

the appearance of similar structures in a certain percentage of "leucocyte" cultures,[3] some of which had been prepared in the same manner as those referred to above. The phenomenon was but casually studied by them, however, and no attempt was made to determine the conditions under which it occurred. It seemed necessary, therefore, to study the matter anew and to ascertain the exact conditions under which the structures arise. It is the purpose of this communication to present the information thus far obtained.

The cells were taken from blood drawn from the carotid of adult chickens according to the procedures regularly employed in the preparation of plasma. After centrifugation, and the subsequent removal of the cell-free plasma yield, the thin superficial layer of plasma containing the buffy coat of leucocytes was coagulated by the addition of a drop or two of embryonic tissue juice. A few minutes later, this layer could then be removed as a disk and cut into small fragments for the preparation of the cultures. Each fragment consisted of a layer of white cells together with such red cells as remained adherent to them. In some cases, the red cells were separated, as completely as possible, from the fragments and discarded. In other cases, a considerable quantity of them was allowed to remain.

The fragments were placed in flasks to which plasma and Tyrode solution had previously been added. In a few instances, the plasma was replaced by serum, thereby eliminating all possibility of coagulation. In certain experiments in which plasma and Tyrode solution were used, a trace of embryonic tissue juice was added in order to induce rapid coagulation. In others, substances were introduced that would stimulate the cells to great activity without the immediate coagulation of the medium, as, *e.g.*, tryptic digest of fibrin. Some of the cultures comprising these various experiments were allowed to remain for a time at room temperature prior to incubation at 37° C. Others were placed in the incubator the moment they were prepared.

These experiments have disclosed the fact that the formation of the capillary-like structures is, in the beginning, a purely physical phenomenon dependent upon the response of the cells to gravity, the consistency of the medium, and the surface peculiarities of the individual cells. As soon as fragments containing both red cells and leucocytes have been placed in a plasma mixture that does not coagulate immediately, certain cells, in passing from a higher to a lower level, initiate a general outflow from the central mass into the surrounding medium. Red cells have smooth surfaces and easily shift their position. Leucocytes, on the other hand, being capable of independent locomotion, adhere to one another and to solid structures. They may, however, be swept along in a current of red cells.

The configuration assumed by the outflowing blood cells depends upon the consistency of the medium and the elevation of the fragment above the general level of that medium. If the medium is composed of serum, the cells flow out from all sides as when a vessel bursts that contains a viscous fluid. In the presence of plasma, however, the outflowing cells may take every conceivable form ranging from broad, fan-like disseminations, through short, stalky, bud-like projections to long, slender ones. It will not be possible at this time to describe more than one type of formation, namely, that which results in the subsequent development of a long, slender tube.

At one or more points on the margin, a few cells become dislodged and break away from the fragment. Their places are taken by those behind. If the proximal impact is great, these cells are also pushed out into the medium. A general streaming begins. Each cell that is forced out follows in the wake of those that have gone before. They may proceed in single file, or abreast of one another, but always over exactly the same route. This route assumes the nature of a tunnel-like passage through the plasma. As long as the cells in the lead are being pushed forward by those from behind, they will continue to advance through the medium until it coagulates. The moment coagulation occurs, however, the cells in the lead, being unable to make further progress, come to a stop. If coagulation occurs before the proximal outflow has ceased, the passage will remain open and unobstructed, despite the fact that the cells in transit may be widely separated If the pathway is only partially filled with cells, they may be made, at any time, to flow in either direction by manipulating the flask. After this happens, the force of the outflowing cells may still be so great that a large spherical expansion is formed at its distal end. Enlargements may also appear elsewhere along the tube. Very often it may be completely ruptured, and occasionally, short branches are found.

All this may occur within half an hour after the cultures have been prepared. As soon as the surrounding medium has become firmly coagulated, however, now further change occurs either in the length of the tube or in its diameter. The structures do not, as Hueper and Russell[2] have reported, continue to grow upon further incubation.

Up to this point, the development of the tubules depends solely upon the rapidity with which the plasma coagulates. A culture held at room tempera-

[3] Although not implied by the title of their report, these cultures contained every cell type present in the circulating blood.

ture develops tubules in greater number and of greater length than a sister culture incubated immediately. Their development is not suppressed by substances that enhance cell activity unless they induce, at the same time, the immediate coagulation of the medium. Embryonic tissue juice prevents their formation by producing immediate coagulation.

So far, the tubules have no definite walls. These begin to be formed very shortly after coagulation has taken place in the medium. The walls do not arise as a direct transformation of the fibrin clot. Instead, they are formed by the activity of living cells, or cell products, the so-called thrombocytes, that have been deposited along the course of the tubule. Where there are gaps between the cells confined in the tubule, these minute bodies may be seen to spin out fine hair-like filaments at the interphase between the lumen of the tubule and the surrounding coagulum. It is believed that the fibrin of the plasma clot serves as a supporting structure upon which the thrombocytes lay down their fiber-like strands. Out in the surrounding medium, these small corpuscles produce similar strands, but here at random. The majority of them tend to agglutinate. Very often, the agglutinated masses become joined together by numerous threads.

After a few days, the red cells within the capillary-like formations become progressively phagocytized by the macrophages. Eventually, these in turn escape into the surrounding medium, sometimes through definite breaks in the walls, but more often by way of their proximal ends. When the tube has become empty, as may occur after 4 or 5 days, any number of macrophages may remain spread out over its outer surface. In this position, they bear striking resemblance to the much discussed cells of Rouget. At times, they are so numerous that their undulating membranes seem to fuse with one another, giving the impression of an unbroken syncytium. If the cultures were fixed and stained at this moment, their nuclei might easily be mistaken for nuclei present in the wall. This apparently accounts for the statement of Hueper and Russell[2] that the wall itself becomes nucleated. This has not been confirmed. When, as may eventually happen, these Rouget-like cells wander away, they leave a fibrous wall that is quite devoid of any cellular structure whatsoever.

Occasionally, the wall is incompletely formed, the fibrillar strands being laid down over a single portion of the original pathway. At other times, a single cord of fibrous material may extend along one side of it, or even this may be absent. Invariably, however, its lumen remains open and filled with the clear fluid that has diffused in from the medium.

To summarize: Isolated blood cells, in a plasma substratum, are capable of constructing highly organized channels that are analogous to the blood capillaries of the organism.

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LAMINAR DESTRUCTION OF THE NERVE CELLS OF THE CEREBRAL CORTEX

One of the structural characteristics of the cerebral cortex is that it is composed of a number of layers of nerve cells. Generally a fundamental subdivision in six layers is accepted nowadays.

Very little is known as yet about the functions of these various layers. It is known that in the giganto-pyramidal area of the cortex (field 4 of Brodmann) the giant pyramidal cells of the fifth layer give rise to most of the nerve fibers descending into the spinal cord as the fibers of the pyramidal tracts. It is assumed on the basis of histological evidence that the three or four outer layers are predominantly receptive in function and that the two inmost layers more particularly subserve efferent functions. Perhaps a few additional, although indeed less probable assumptions could be made, but that would be all. Our factual knowledge of the functions of these various layers is as yet very restricted. This is largely due to the stupendously complex structure of this tissue, but also to the fact that until now no method has been available which permitted an experimental attack upon the various layers of the cortex, and by that a direct approach to their respective functions.

In this preliminary paper I want to describe briefly a simple method which makes possible destruction, at will, of consecutive layers of the nerve cells of the cerebral cortex, *i.e.*, of either its first two superficial layers, or of the first four, or of all the six layers. This is possible by applying heat locally to the exposed cortex for a very short period. It was found that heating to 90°–100° C. for five seconds results in death of all the nerve cells in the heated area throughout the whole thickness of the cortex, and that, by heating it to about 70° C. for from one to two seconds, it is possible to kill the nerve cells of only the two superficial layers.

The apparatus used in these experiments is very simple. The copper tip of an ordinary electric soldering-iron is sawed off so that a rectangular surface of appropriate size (5 × 7 millimeters) is obtained. This surface can be heated to any temperature suitable for our purposes, by taking off the proper voltage from a potentiometer-rheostat (of f.i. 600 ohms, 1 Amp.) plugged into a power outlet. For special purposes copper tips of various size and shape are used, which can be screwed into the stem of the soldering-iron. A series of settings of the rheostat was established for a few suitable temperatures (60, 70, 80, 90, 100° C.) for each type of copper tip used. The temperatures of the tips were determined in the usual

way with thermocouples and a ballistic galvanometer. These experiments were performed on monkeys (*Macacus rhesus*) under sterile conditions; the animals were killed after one or two weeks and the changes in the cerebral cortex studied by the Nissl method.[1]

The lesions are found to be strictly localized to the heated area. It shows as an encapsulated area, sharply marked off from the surrounding normal cortex by a wall of proliferated connective tissue and blood-vessels. The nerve cells within this area have all disappeared; those immediately outside this wall of connective tissue show a normal Nissl picture. Of great interest is the fact that the neuroglia inside the damaged area is not killed, but is found to have reacted to the heating by proliferation. Even a temperature of 130° C. applied for ten seconds does not kill the cortical neuroglia.

This method of laminar thermo-coagulation of the cerebral cortex, as it might be called, results, therefore, within a wide range of temperatures, in a sharply localized, selective destruction of the nervous elements. By selecting a suitable temperature and a suitable period of application of the heat it is possible to destroy, at one's discretion, the nervous elements, the nerve cells and their processes, in consecutive layers of the cortex.

Details can not be given in this preliminary paper; suffice it to point out that this method permits a new attack upon many important problems in the fields of physiology, anatomy and experimental pathology of the cerebral cortex.

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LITHIUM IN SEA WATER

COMPARATIVELY little is known concerning the distribution of the rarer alkali metals in nature in spite of the intrinsic interest of the subject. Beyond the fact that the order of occurrence is probably Na, K, Li, Rb, Cs, Va, no quantitative data are available to enable us to assign numerical ratios to this series. Even in the case of sea water, which has been extensively studied by so many investigators since the beginnings of chemistry, quantitative determinations of the alkalies, lithium, rubidium and caesium are practically non-existent, and virginium has only recently been discovered. Analyses by Schmidt,[1] frequently quoted in works on oceanography and geochemistry, give values as high as 0.04 per cent. of rubidium in sea salt, but examination of Schmidt's original paper shows that his results are based upon indirect analysis with a very high probable error. Grandeau,[2] who found rubidium in beet root, failed to detect the element in sea water and also mentions Bunsen's failure to find it.

So far as the authors know there is no published account of even the detection of caesium in sea water. In some works on oceanography its identification is attributed to Sonstadt, but in every such case the writer has overlooked Sonstadt's[3] admission that the spectrum lines he thought were due to caesium were actually given by strontium.

As far as is known, the authors report in this paper the first quantitative determination of lithium in sea water. In this procedure a liter sample is used. The calcium and magnesium are removed by precipitation with sodium carbonate. This precipitate is dissolved and reprecipitated in order to avoid the possibility of loss of some of the lithium with the carbonates.

The filtrates from the two precipitations are combined and evaporated, the magnesium carbonate which continues to precipitate as the solution evaporates being removed by filtration from time to time. When the volume is about 100 ml the solution is filtered and acidified with hydrochloric acid. The evaporation is then continued in the acid solution.

When sodium chloride begins to separate the solution is cooled, and an equal volume of ethyl alcohol is added, which precipitates much of the sodium chloride. This is filtered off, washed with a little 50 per cent. alcohol and evaporation of the filtrate continued. The sodium chloride is reserved for subsequent treatment.

When sodium chloride again begins to crystallize from the solution, the above procedure is repeated, and this is continued until the volume is about 10 ml. The precipitation may also be accomplished with hydrogen chloride gas.

At this point all the sodium chloride which has been removed is dissolved in water and reprecipitated by the same process of alternate evaporation and addition of alcohol until the volume of solution remaining is about 5 ml. This is added to the 10 ml of filtrate from the first procedure. Reprecipitation of the sodium chloride is necessary to avoid loss of some of the lithium with the sodium chloride.

An equal volume of alcohol is added to the combined filtrates and the solution is saturated with dry hydrogen chloride. The greater part of the remaining sodium chloride and sulfate and some potassium is removed by this operation, and the solution is evaporated to dryness.

It is now necessary to remove the remainder of the magnesium. The residue from evaporation is dissolved in 20 ml of 50 per cent alcohol, 2 ml of normal sodium carbonate solution is added, and the solution is boiled. The precipitate is filtered off, dissolved and reprecipitated to avoid any possible loss of lithium. The combined filtrates from the two pre-

[1] I am greatly indebted to Dr. Harry M. Zimmerman, of the department of pathology, for the preparation and help in interpretation of this histological material.

[1] Schmidt, *Bull. Acad. St. Petersburg*, 24: 231, 1878.

[2] Grandeau, *Comp. Rend.*, 53: 1100, 1861.

[3] Sonstadt, *Chem. News*, 22: 25, 1870; *ibid.*, 22: 44, 1870.

cipitations are acidified with hydrochloric acid and evaporated to dryness. The residue is dissolved in a minimum amount of water, alcohol is added until the volume is 10 ml and the solution saturated with dry hydrogen chloride, filtered and the sodium chloride washed with absolute alcohol. The filtrate and washings are evaporated to dryness.

The residue, weighing a few milligrams, consists largely of potassium chloride and sulfate, some sodium and magnesium chlorides, and contains the lithium.

Complete separation of the lithium and its direct determination is impracticable, but it may be estimated by use of the spectroscope with comparative ease. The authors use an atomizer (zerstäuber) especially designed to spray a solution into the air inlet of a blast lamp so that the spectrum may be observed continuously.

The solution rises by capillary action in the tube A (Fig. 1) which is open at the point B and sealed off

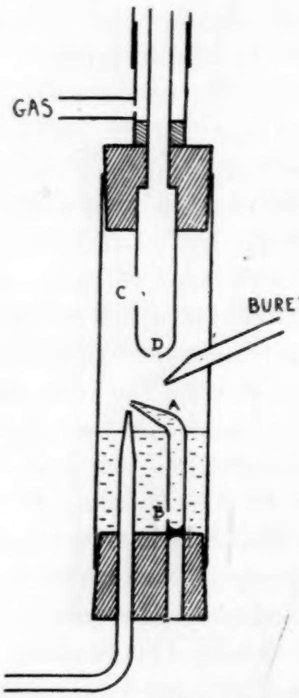

FIG. 1. Apparatus used in the quantitative spectrum analysis for lithium.

just below this point. The air blast produces a fine spray, and a small quantity of this is carried up through C into the burner. The opening at D permits any excess to drain back without interfering with the passage of the spray into the tube. The tube sealed into the side allows solutions to be added during the course of the analysis. The lower part of the apparatus is made of glass, but the burner proper is of brass.

The residue containing the lithium is moistened with a drop of hydrochloric acid, dissolved in two milliliters of water and washed into the reservoir of the atomizer with an additional two milliliters of water. Then, while the spectrum is being observed, a 3 N solution of potassium chloride is added until the red potassium line at 7666 Å is of sensibly the same intensity as the red lithium line 6708 Å. This requires some skill and judgment, since the lines are of somewhat different color. With practise, however, results with known quantities of lithium can be duplicated with an accuracy comparable with other methods of quantitative spectrum analysis.

This method is also useful for estimating small quantities of strontium in the presence of much calcium, using the blue lines of the two elements.

The solution is removed quantitatively from the atomizer (the quantity which was used in the burner is negligible), evaporated, and the residue weighed as potassium chloride.

This entire procedure is duplicated with a synthetic sea water containing a known quantity of lithium and a ratio established between the lithium and potassium, which will give equal intensity to the two lines. This ratio will depend upon the apparatus and to some extent upon the experimenter. The authors found a value of 2: 10,000. Since the quantity of potassium chloride actually weighed is relatively large, the results are unaffected by the small amounts of sodium and magnesium which may be present.

In this way the lithium in sea water of ordinary concentration (chlorinity = $19\ ^{0}/_{00}$) has been determined to be 0.1 mg per liter.

The importance of lithium in the economy of the sea is not known. No quantitative estimations of the element in the various organisms have been made, although it has been reported qualitatively by many. Possible variations in the quantity of lithium present in sea water, due to marked growth of plankton, are also unknown. The accuracy of the method does not permit, nor does its tediousness encourage, the determination of such fluctuations.

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